OCT 20 1927

Telephone Engineer

VOL. 31, No. 10 CHICAGO

The Research Expert's Part in Strowger Automatic Leadership

FROM the inception of the automatic idea, the Research and Development Staff of Automatic Electric Inc. has played an important part in the development of the art of automatic telephony.

The perfection of Strowger Automatic telephone equipment to its present state of highly satisfactory and economical operation, has not been due to chance or guesswork. It is rather the result of detailed and scientific study by highly trained and experienced engineers, using the latest and best experimental equipment and methods known to the world of science.

The reliability and efficiency which have become synonymous with the name Strowger have resulted from a consistent policy of development which, while encouraging new ideas, always subjects them before adoption to the conservative judgment and tempered wisdom of long experience.

Automatic Electric Inc.

Factory and General Offices: 1033 West Van Buren St.
Chicago, U. S. A.

STROWGER AUTOMATIC

OCTOBER, 1927

INSECT PROOF
45' and 50' International Creosoted Pine Poles near Beaumont, Texas, in interurban service and Southwestern Bell Lines.
SECURITY
International Creosoted Pine Poles entering business section of Florence, South Carolina.

Complete

STRENGTH—Southern Yellow Pine is strongest and most uniform of pole woods, being 44% stronger than the other pole woods.

LONG LIFE—Leading public utility organizations estimate a life of 35 to 40 years. ***International*** has poles in service 28 years with less than 1% renewals.

INSECT PROOF—Creosoted Poles proved highly resistant to white ants and woodpeckers in localities where they had completely riddled other poles.

SECURITY—Greatest permanent strength and greatest security are assured because these poles do not decay. All hardware holds firmer, which secures circuits and makes climbing safer for the linemen.

INTERNATIONAL CREOSO

Genera

Plants:

Intern

Pressure Creosoted

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Telephone Engineer

Volume 31 OCTOBER, 1927 Number 10

"Not Afraid to Ask" Is Success Secret

It was late in the evening when only a few positions of a long toll switchboard were occupied, that a transmission tester sat at one of the positions with his instruments about him. He was engaged in his routine duties of measurement of lines and cords to make sure that some hidden defect might not interfere with the tiny voice currents in their journey through the circuits.

Two men came into the operating room on a tour of inspection around the switchboard and finally stopped at the position where the transmission tests were being made. One was a gray-haired veteran whose service record commenced in the days when the telephone was scarcely out of its infancy. The transmission tester recognized him as the district commercial manager of the area in which the city was located. The other was a much younger man; one who must still have been in short trousers when the elder had already reached a place of responsibility in the business.

The two men stopped at the transmission equipment and inquired as to the purpose of the tests. The younger man became much interested and asked many questions about the equipment and about the effect of the testing upon the quality of the service being rendered. He even sat down and under the direction of the tester, adjusted the instruments and read the results. The older man was obviously anxious to go on, but could do nothing but wait until his companion was ready to move on. A few days later, through a photograph in the employees' magazine of the company, the transmission tester recognized his visitor as the new vice-president and general manager of the company.

If we were writing this as a story for the inspiration of youth, we might go and tell how rapid promotion came to the transmission tester on account of his courteous reception of the stranger who happened to hold a high position. This we can not do for we do not know that the incident had any influence whatever on the career of the transmission tester. We are only telling the story in order to give voice to the opinion that the reason that the younger man was vice-president and general manager and the older one was in a position subordinate to him was almost completely explained by the attitude of the two men when they came into contact with a phase of the operation of a telephone plant that was strange to them.

"Free Service" Burden Is Loaded on by Minority

In a recent Missouri decision the petition of a telephone company to eliminate free service between two groups of exchanges was denied. The petition apparently was based largely upon the fact that the line used for the service had depreciated to the point where rebuilding was necessary and the company did not feel justified in spending several thousand dollars to rebuild a line from which it derived no direct revenue.

The commission's finding was that the rate schedule approved several years ago included a sufficient amount to provide a fair return on the value of the entire property and in the absence of a showing that the entire property was receiving insufficient revenue, no toll charges should be permitted; that a sufficient amount had been allowed for depreciation to permit the company to retire its plant as it became worn out and that, in the absence of complaint from subscribers that service was unsatisfactory, this phase of the question should not be considered.

Several cases have come to our attention lately, in which permission to discontinue free service between exchanges was denied and it seems that companies have failed to set up the real reasons for its evils of free inter-exchange service, but the application of toll charges may not always be the proper solution. There may be areas where the community of interest is sufficient to warrant continuation of the free service if the exchange rates can be made sufficiently high to pay the cost. In other cases the local service may be so limited that a living rate may be more than the worth of the local exchange service.

In the cases where free service should be eliminated in order to give a legal basis for a commission order, it would be necessary to show that the company is not receiving a fair return and that the subscribers were unable or unwilling to absorb the cost of the free service in the local rates. A far stronger reason, however, is found in the essentially discriminatory character of the free service. Studies have shown that in many exchanges half their subscribers never use the free service; that another large group use the free service so infrequently that toll costs would be negligible and that relatively a small group of subscribers are the users of practically all of the service.

It is this latter group that appears in force at hearings and makes loud and long objections to the withdrawal of the service. They are frequently supported by members of the other groups who do not understand the situation and who are led to believe that something is being taken away to which they are entitled by right and custom. Commission decisions are bound to be influenced by these groups unless their demands are opposed by a clear showing that they are asking a preference in service which the law does not permit.

Sales Forced by Financing Problems

John Brown owned the telephone exchange at Jonesville. He started it many years ago as a side line to another business and it grew until it demanded more of his time than the other business would permit him to give. Opportunity to sell the other business came and he sold, investing the proceeds in the extension of the telephone business. Being progressive-minded, he extended the business as fast as service was demanded and solicited new business wherever it could be obtained at a profit.

As the system grew, he added cables and installed new equipment to give his subscribers advantage of improvements of service. He charged a rate that gave him what his state commission described as a fair return on the value of the property. As the business kept growing, he found that the reinvestment of the earnings did not provide sufficient capital for expansion, and having good credit he borrowed from the local bankers.

As time went on, he found that additional capital funds were required and his borrowings increased rather than decreased. Finally, the bankers suggested casually that he ought to begin to reduce the indebtedness instead of renewing the notes and borrowing more and later their suggestions became so pointed that he was forced to look to other sources for funds. Friends in the telephone business suggested that he issue bonds, and so he made up a statement of his earnings and assets and interviewed the local bankers with a view of converting his notes into long-time bonds.

The bankers were sympathetic but unacquainted with utility problems and gave the usual answers of the necessity of keeping liquid their funds and the lack of local demand for such securities. He then took his statements to a city bond house and again received a courteous reception, but was told that the issue was so small that it could not be handled by the bond house. Other interviews with other financial houses gave the same result.

One day a stranger dropped into his office and asked him to place a price on the property. John Brown did not want to sell. He had a good property and was satisfied to remain in the business, but his ever present financial problem was before him and he finally named a price that would enable him to pay off his indebtedness and have a nice sum for his interest in the business. He sold.

The telephone industry lost a valuable man when John Brown disposed of his property and found another line of work. It is not easy to find that anyone was to be blamed for the situation, but it was a case where a telphone owner was practically forced to sell his property because he was unable to find a method of financing which would permit him to go ahead and develop it.

This problem received much discussion two or three years ago at national and state conventions but the answer was not found. It has been assumed that financial difficulties in the business are over, but the actual fact is that there are still telephone owners in the same position as John Brown was. They do not want to sell but may be compelled to as the only way out. The welfare of the industry requires that a method be found to finance such properties in a way that will permit John Brown and his like to stay in the business.

Signs Point to Record Meeting for U. S. I. T. A.

As the time for the 1927 annual convention of the United States Independent Telephone Association draws near, it becomes apparent that the meeting will be one of the most important that the Independent Telephone group ever has held. The general programs are packed full of good things and the meetings of the various divisions are planned to give real assistance to those who attend. It is interesting to the smaller operators to know that the joint session of the accounting and plant divisions will be devoted to the application of methods of handling depreciation for this class of company. It may be taken for granted that the discussion will be based upon concrete facts rather than theoretical consideration. Altogether, we are looking forward to a very successful convention.

How Safety Code Applies to Communication Lines*

By ARTHUR HALSTED
Associate Electrical Engineer, Bureau of Standards

The Bureau of Standards has published the various parts of the National Electrical Safety Code, revised for the fourth edition, as separate volumes. Five separate handbooks taken together, supersede the third edition of the code known as Handbook No. 3 of the Bureau of Standards.

The present edition of the National Electrical Safety Code is the result of a revision that has been carried out according to the procedure of the American Engineering Standards Committee.

Handbook No. 6 comprises Part 1 and the grounding rules and is entitled "Safety Rules for the Installation and Maintenance of Electrical Supply Stations." Power generating and transforming equipment used in the operation of communication systems, when installed where accessible only to qualified operators, may assume the status of a power substation and as such is within the scope of rules in this part of the code.

Handbook No. 7 comprises Part 3 and the grounding rules and is entitled "Safety Rules for the Installation and Maintenance of Electrical Utilization Equipment." The grounding rules apply to the grounding of all circuits, equipment, or wire runways when the grounding is intended to be a permanent protective measure, except the grounding of lightning arresters on communication circuits. The grounding of lightning arresters for communication circuits and other protective requirements for communication apparatus that must be handled by persons, are treated in the last section of this part. Protective devices such as the fuses and arresters ordinarily installed in connection with subscribers' stations are required where the circuits are exposed to lightning or to crosses with supply circuits of more than 400 volts to ground.

Handbook No. 8 comprises Part 4 of the code and is entitled "Safety Rules for the Operation of Electrical Equipment and Lines." The rules in two sections of this handbook apply to the operation of commercial telephone, telegraph and other communication equipment and lines. One of these sections includes rules for the promotion of safety applying to the employer, and the other section includes rules to be observed by the employes.

Handbook No. 9 comprises Part 5 of the code and is entitled "Safety Rules for Radio Installations."

Handbook No. 10 comprises Part 2 of the code and is entitled "Safety Rules for the Installation and Maintenance of Electrical Supply and Communication Lines."

The following paragraphs will indicate some of the rules of the code applying to communication lines which are defined as conductors and their supporting structures used for signal or communication service, operating at not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and in which the transmitted power does not exceed 150 watts. When operated at less than 150 volts no limit is placed on the capacity.

Communication Lines Alone

Overhead communication lines not involved with supply lines and railways are affected by the code only as to clearance and some climbing space requirements, and those most widely applicable will be indicated in brief.

Poles should be set at least 3 feet from fire hydrants and 6 inches from curbs. The minimum conductor clearances above ground vary with varying situations, from 18 feet where spans are less than 150 feet over city streets to 13 feet along highways where it is unlikely that loaded vehicles will be crossing under the line into fields, and 10 feet over driveways to residence garages and spaces accessible to pedestrians only. Six inches is specified as a preferable minimum horizontal separation between communication conductors at overhead line supports. This separation does not apply, however, to transposition points, and a 3-inch separation is permitted where pin spacings of less than 6 inches have been in regular use. A table gives minimum clearance in any direction from line conductors to supports, span or guy wires, and vertical and lateral conductors attached to the same support. Under the majority of conditions affecting communication conductors this clearance is 3 inches. At wire crossings where communication wires cross over communication wires and cables, a vertical clearance of 2 feet is specified, that may be reduced by consent of regulatory authority.

No climbing space or working space on poles is specified for communication conductors that do not carry more than 150 volts to ground and are not involved with supply conductors. When the voltage of the conductors exceeds 150 to ground a climbing space is specified at one corner or side of the pole, 24 inches along and 24 inches across the line in horizontal dimensions and projected vertically not less than 4 feet above and below the limiting conductors.

Where within 8 feet of the ground all vertical conductors, cables and grounding wires must have a covering that gives mechanical protection. For grounding wires from lightning arresters the covering is to be of wood molding or other insulating material. A number of exceptions, however, permit the covering to be omitted from lead-sheathed cables installed in grounded-metal conduit, lead-sheathed cables in rural districts, circuits on fenced rights of way in the case of conductors or cables from underground systems, and grounding wires in rural districts having triple-braid weatherproof covering or grounding wires used to provide multiple grounds.

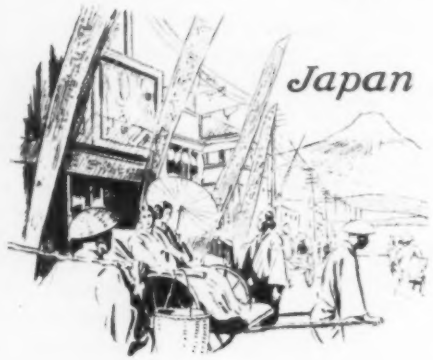
Communication Lines Involved with Supply Lines or Railways—Clearances

Where communication lines are involved with supply lines or railways, specifications affecting them are more numerous and complete. These specifications begin with a section devoted to relations between various classes of lines, recommending that the relative levels of different classes of lines be standardized by agreement for any given community. Where supply and communication conductors cross each other, or are in conflict or are located on the same poles, the supply conductors shall preferably be carried at the higher level.

The code recognizes that joint use involves contractual relations between utilities, consideration of service requirements, and economics, as well as safety. In the case, however, of local or distribution circuits, enumerated in detail, the code states that joint use is generally preferable to separate pole lines. In all cases joint use is preferable to separate pole lines when an overbuilt conflict can not be avoided.

The code especially affects communi-

*Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.



Meeting Modern Tel
at Every Poin th

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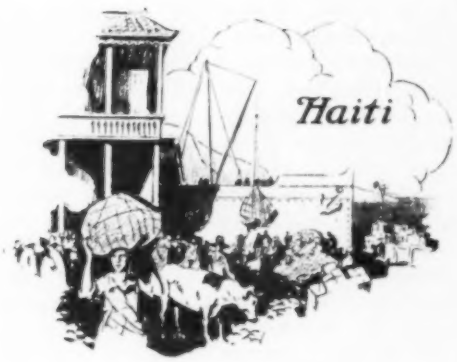

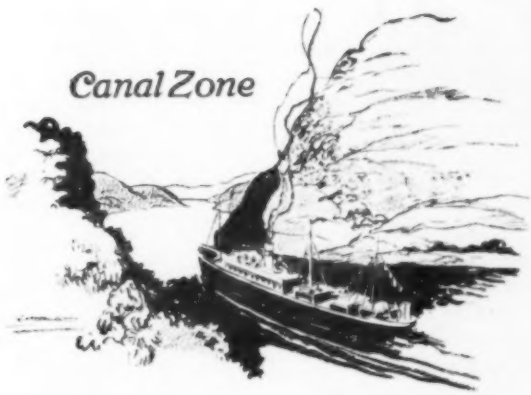

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cation lines in the case of joint use, conflicts and crossings with supply lines. Crossing clearances are given in an itemized table. Where the sum of the distances from the point of crossing to the nearer supporting structure of each span does not exceed 100 feet the specified clearances begin with a minimum value of 2 feet where the crossing is between communication conductors and supply service drops, increasing to a minimum of 4 feet where supply-line wires from 0 to 7,500 volts are involved. This crossing clearance increases with increasing voltage of the supply conductors and span lengths involved.

In the case of separate conflicting lines, minimum values of separations between conductors of the lines are given, governed by the voltages and sags, with 4 feet as a minimum value in all cases. The clearances of conductors from supporting structures of another line are similarly specified with 3 feet if practicable, as a minimum.

On jointly used poles, separations between horizontal crossarms, conductors, cables and equipment located at different levels are specified. The minimum separation between crossarms carrying communication conductors and crossarms carrying supply conductors of from 0 to 7,500 volts, is generally 4 feet, from 7,500 to 50,000 volts it is 6 feet, and increases with increase in voltage of the supply lines.

On jointly used poles, climbing-space and working-space requirements become applicable to communication circuits. The horizontal dimensions of the climbing space through communication wires below supply wires should be the same as required for the supply conductors immediately above. These dimensions vary with the voltage of the supply conductors, being 24 inches where the supply conductors are of less than 300 volts to ground, 30 inches for supply conductors of less than 7,500 volts between wires, 36 inches where the supply circuits are of 7,500 to 15,000 volts, and more than 36 inches for higher voltages.

Where communication conductors cross railroads handling freight cars on top of which men are permitted, a clearance of 27 feet above the rails is specified, modified in exceptional cases by permitting a reduction to 25 feet. Above street railways a clearance of 18 feet is required, which is the usual minimum clearance above alleys and roads. These clearances above track rails are increased for spans exceeding 150 feet in length.

Grades of Construction

For purposes of strength requirements, conductors and supporting structures are classified under a number of grades of construction on the basis of the relative hazard existing, namely, Grades A, B, C, D, E, and N. These grades constitute two series—Grades A, B, C, and N, and Grades D, E, and N. Grades D and E apply only to communication lines crossing railways and cannot be directly compared with the series A, B, and C, that apply mainly to supply lines but under some circumstances also to communication lines. It is possible for two or more conditions affecting the grade of construction to exist simultaneously; in such case the grade of construction used is to be the highest required by any of the conditions. The relative order of the grades is A, B, C, and N, grade A being the highest. Where grades D, E, and N are specified for communication lines, grade D is the highest. Specific rules provide for the few cases where it might be necessary to choose between these two series of grades as to relative order.

Although communication lines under certain conditions are expected to comply with the strength requirements of Grades A, B or C, the majority of communication lines coming under a grade of construction that includes strength requirements, take Grade D or E. There are no loading assumptions or special strength requirements applying to Grade N communication lines. Grades of conductors are determined by what is below them, including the nature of the conductors, railroad tracks, or terrain below, modified under some conditions by the classification of the conductors themselves, whether "major" or "minor" communication circuits. "Minor" communication lines means lines carrying not more than two circuits used mainly for local telephone or telegraph service. In some situations the strength requirements are less where only such circuits are involved.

The conductors and supporting structures of a line crossing under another line need have only the grade which would be required if the line at the higher level were not there. The grade of each conductor and the grade of each element of its support is determined independently. The grade required may depend upon the nature of the conflict existing. Conductor conflicts and structure conflicts are recognized and defined independently. Structure conflict means that the line is so situated with respect to a second line that the overturning of the conflicting line will result in contact between its poles or conductors and the conductors of the second line. Conductor conflict means that a conductor is so situated with respect to a conductor of another line at a lower level that its breakage would likely result in a contact.

The grade of each conductor when alone or in the upper position at crossings, at conflicts or on joint poles is determined from a convenient table. Instances are as follows: Communication conductors over main line railroad tracks are Grade D; over minor railroad tracks Grade E; communication conductors over constant-potential supply conductors of from 750 to 5,000 volts Grade C; over constant-potential open supply conductors of from 5,000 to 7,500 volts, Grade B; over supply conductors exceeding 7,500 volts, Grade A. Communication conductors alone are Grade N.

The grade of the supporting structure usually follows from the grade of the conductor supported. Each element of the supporting structures, including poles or towers, crossarms, pins and insulators, and conductor fastenings, is treated separately. As a general rule the grade of construction of the supportnig structures will be that of the highest grade of conductor supported. There are, however, a number of exceptions to the general rule. The grade of construction of poles used only by communication conductors or as joint poles, need not be increased because communication wires carried on such poles cross over trolley contact conductors of 0 to 750 volts.

At structure conflicts, even though no conductor conflict exists, the grade of construction of the pole will be that which would be required if the conductors supported were in conflict. This may result in a higher grade of construction for the pole than for the conductors carried. In the case where a structure conflict does not exist, but a conductor is in conductor conflict, the grade of construction of the pole is not required to be the same as that specified for the conductor on account of the condition of conflict.

Loading Assumptions

As a basis upon which to compute the strength requirements for Grades A, B, C, D, and E, wind and ice loading assumptions are made. Three degrees of severity are recognized for the loading and are designated respectively as heavy, medium and light loading. The districts in which these loadings apply are determined by weather reports as to wind and ice, and by local experience of utilities using overhead lines. The localities in which the different loading assumptions apply are classified according to the relative prevalence of high wind velocity and thickness of ice that accumulates on wires, light loading being for places where little, if any, ice ever accumulates on wires. A map of the United States in the code indicates the general boundaries of these districts.

The following weather conditions are assumed to act simultaneously in different loading districts:

	Radial thickness of ice, inch.	Horizontal wind on projected area, lbs. sq. ft.	Temperature, ° F.
Heavy loading.	½	8	0
Medium loading	¼	8	+15
Light loading.	none	12	+30

Where cables are concerned the ice covering and wind pressure are applied to both cable and messenger.

The assumed vertical loads on supporting structures are their own weight plus the superimposed weight of all wires and cables, ice-coated in heavy and medium loading districts, together with the effect of any difference in elevation of the supports.

The transverse loading on supporting structures in heavy and medium loading districts ordinarily assumes the full ice and wind loading; however, for supporting structures carrying more than 10 wires (not including cables supported by messengers), where the pin spacing does not exceed 15 inches, the transverse load is calculated on two-thirds of the total number of such wires with a minimum of 10.

In light loading districts the transverse force is assumed to be a horizontal pressure of 12 pounds per square foot of projected area of the cylindrical surfaces of all supported conductors and messengers, and poles or towers without ice covering.

In cases where an unbalanced side pull due to change in direction of lines is imposed on the supporting structure, a transverse load shall be assumed equal to the resultant of all conductor and messenger tensions under loaded conditions (ice, wind and low temperature). In calculating transverse strength, the assumed transverse and vertical loads are to be taken as acting simultaneously.

In calculating longitudinal strength the assumed longitudinal loads shall be taken without consideration of the vertical or transverse loads. At dead ends the longitudinal loading upon supporting structures is taken as an unbalanced pull equal to the sum of the tensions of all conductors and messengers under loaded conditions. On unguyed communication conductor supports at railroad crossings, the longitudinal load is assumed equal to an unbalanced pull in the direction of the crossing of all conductors supported, the pull of each conductor being taken as one-half its ultimate strength. A table of longitudinal guying makes it unnecessary to compute the longitudinal load for guyed poles.

Where lines cross over railroads, the poles supporting the crossing span and the adjacent spans should be in a straight line if practicable. The crossing span shall be as short as practicable, never exceeding the 125 feet if this can be avoided, and in general shall not be longer than the normal span of the line.

Where poles are guyed the poles are considered to act only as struts. Guys used for transverse strength are considered to take the entire load in the direction in which they act, without exceeding 50% of their ultimate strength for Grade D or 75% for Grade E.

A table of minimum sizes of conductors is given. Where spans are 125 feet or less in heavy loading districts, No. 10 A. W. G. hard copper is specified for both Grades D and E. For the same span, No. 10 Stl. W. G. galvanized steel is specified for Grade D and No. 12 Stl. W. G. for Grade E. Tables of minimum stringing sags are also given. For a 100-foot span, in heavy loading districts, the minimum sag is 7 inches at 60° F. Tables of minimum sizes and working tensions of messengers supporting multiple-conductor cables are given.

Following overhead lines, a section in the code treats of underground lines applying to communication circuits when alone and also when affected by the proximity of supply circuits and railway tracks.

Independents Set Stage for Epochal Convention

Chicago, Ill.—This year's annual convention of the United States Independent Telephone Association is expected by many to be the most significant session ever held by the Independent sector of the industry. The point upon which attention will be focused is, of course, just what has been the effect of the past twelve months of activity in merging, selling and new financing in the Independent field. What new faces will be seen at the convention? Whose voices will be raised for the first time in deliberating on the problems, the trials, the triumphs and the future of the Independent? Curiosity concerning those subjects is expected to bring out a full attendance of the old guard whose interests remain strong in the industry, and of those who have been rather passive in their attitude toward conventions in the past, but who now are anxious to see just what the new alignments will bring forth when the curtain is raised at Hotel Sherman, Chicago, October 18.

Although the stampede of buying and selling operations is considered by some of the qualified judges to have died down before much harm could be done by the wild-cat so-called financiers who made desperate efforts to exploit the industry, the entire situation will be subjected to an expert analysis at the convention.

There is considerable evidence in the advance details of the program that the ring-leaders of the Independent group are answering with a strong affirmative to the question of whether or not they consider themselves the keepers of their weaker brethren. A number of the stars of each phase of telephone activity will appear before the general and divisional sections assigned to subjects of intense practical interest to the smaller companies. President F. B. MacKinnon of the Independents stresses this feature of the program in asking all member companies to call up their neighboring companies that do not belong to the association and urgently invite them to attend the Chicago sessions.

Program Outlined

Regarding the program, Mr. MacKinnon states:

"The program this year will again feature special divisional sessions with an additional division being organized—the commercial division—which will give consideration to rates, publicity methods, contract forms, advertising, etc. One general session of the convention will be given over to the commercial division, led by its chairman, R. F. Wilder, commercial superintendent of the Tri-State T. and T. Co., St. Paul, Minn.

The accounting and plant divisions will hold a joint luncheon session for the consideration of the accounting procedure to be followed by C class companies in complying with the Interstate Commerce Commission depreciation order. The association accountants have been endeavoring to systematize the accounting procedure of the A and B companies and are now directing their attention to the C companies. The procedure that will be adopted for these companies will be of interest to the D companies, particularly to those nearing the C class.

"On the same day the luncheon of the traffic division will be held with the usual program of interest to traffic superintendents and chief operators; and the new commercial division will hold its first luncheon.

"On Thursday, the third day of the meeting, the special number on the program will be an address by S. P. Grace, commercial development engineer of the Bell Telephone Laboratories, on recent products of the laboratories. This will be of interest to everyone. Mr. Grace, an old time Independent, has addressed us before and we will be glad to welcome him again.

"In addition to these special numbers there will be the regular business and general sessions with special addresses and of course the annual lunch of the Pioneers."

Get Reduced Rail Fares

The Independent association is doing all that it can to get the convention attendants to secure convention certificates along with their railroad tickets so half-fare may be had on the return trip.

(*Continued on page* 46.)

Wave Distortion on Long Telephone Lines*

By F. J. DOMMERQUE
Fellow A. I. E. E.

83. Effect of Magnetization Upon Current Curve

As the complex waves of sound are converted in the transmitter into variable currents possessing the same wave form, and as the sound waves are composed of a number of simple or sine waves, it becomes a matter of necessity that the form of these component sine waves is retained during transmission. The nearer their shape is reproduced at the far end, the more efficient the transmission. Fortunately changes in phase such as usually are obtained are not of importance, as the effects are not noticeable by the listener. It has also been observed that, if the amplitudes of the component waves are varied uniformly over not too great a range, the quality of transmission will not suffer appreciably. The danger of deterioration of transmission by distortion comes from two sources, the apparatus not being designed with due regard to avoidance of distortion and the line not reproducing the frequencies of the received waves with the same relative intensity possessed by the original sound.

In all coils used in conjunction with the talking currents, iron cores are employed, therefore hysterisis and eddy currents are liable to cause detrimental distortion. It will be of interest to illustrate the effect magnetization has upon the current curve. In Fig. 95a the magnetization curve is plotted, having as abscissae the values of the magnetizing force H and as ordinates the values of the induction B. As current curves are plotted with respect to time, a new magnetization diagram is introduced having the time as abscissae, and a sine curve having the value OA of Fig. 95a as amplitude, OA being the maximum value of the magnetizing force. Other points of the curve are obtained by finding ordinates on the given sine curve in Fig. 95b, thus: $1'1''=01$; $2'2''=02$; and so on. Prolong these ordinates and lay off on the prolongations from the time axis the corresponding values of the induction B, thus: $1'1'''=11°$; $2'2'''=22°$ and so on. Connect the points so determined and obtain the curve of induction with respect to time, showing the manner in which the magnetization varies under the influence of a sinusoidal current.

If the permeability of the iron were constant, an induction curve similar to the current curve would be obtained, but as the permeability decreases while approaching the maximum value of the current the induction curve results in a flat top curve.

Should it be desired to produce a sinusoidal curve of magnetization, the current curve required may be found as follows: Starting out with the magnetization curve in Fig. 95c, whose amplitude is equal to the maximum ordinate of the induction curve in Fig. 95a, select values on that curve in Fig. 95c, corresponding to the several values of the induction B in Fig. 95a, thus: in Fig. 95c, 11″; 22″; 33″..... are taken respectively equal to 11°; 22°; 33°..... in Fig. 95a. Erecting these ordinates in Fig. 95c, lay off on them corresponding values of the current given in Fig. 95a, thus: in Fig. 95c make $11'''=01$; $22'''=02$; $33'''=03$..... Connecting the points so found gives the current curve required to produce a sine wave of magnetic induction. It will be observed that, as the induction increases the current increases in greater ratio, showing that, as the permeability decreases, it must be compensated for by further increase of current or ampere turns.

To investigate the influence of hysterisis, the hysterisis loop is repeated in Fig. 96a and a construction performed analogous to that given before. Since the descending values of the magnetic induction are greater than the ascending values after we have passed the maximum value of the current we find that the second quarter of the magnetization curve is not symmetrical with the first quarter but that the ordinates are uniformly higher corresponding to the same values of the current. The same condition repeats itself during the reversal of the current, when the curve is plotted below the time axis. In addition to the distortion in evidence the magnetization curve is shifted with reference to the current curve, due to the lag produced by hysterisis. This will be understood by considering that the zero values of magnetizing force and induction are not coincident, the zero values of the latter occurring later than those of the former as shown in Fig. 96b.

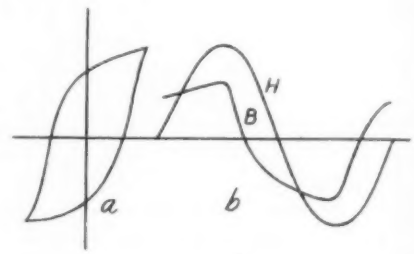

Fig. 96

Hysterisis affects the construction of Fig. 95c in a similar manner, as after passing the maximum value of the induction corresponding with a given current, the magnetization is proportionately greater. To have the same magnetization on the descending as on the ascending side of the curve, the current required will be correspondingly less; for that reason in Fig. 97 after reaching a maximum value of the current, the ordinates of the curve on the right of that ordinate are less than those on the other side. We have again distortion of the curve due to hysterisis. At the same time the two curves are shifted relatively

*19th article on Telephone Mathematics and Physics.

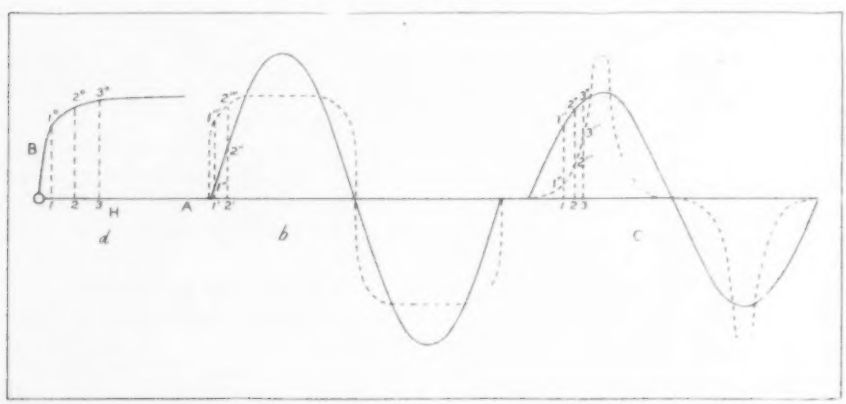

Fig. 95

to one another, as shown in Fig. 97, the same as stated before.

In the design of cores suitable for telephone induction coils and other coils used in conjunction with talking currents it becomes of the greatest importante that the magnetism produced by the quick variations in the currents be always proportional to the intensity of the current;

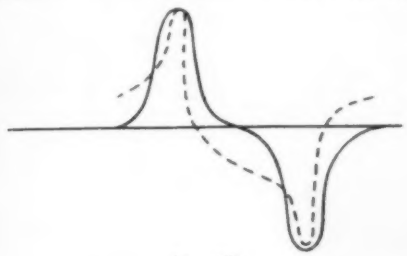

Fig. 97

therefore the cores must have low hysterisis, which can be effected by using thin rods or wires of iron magnetized longitudinally. To avoid eddy currents and their retardation in magnetization, a core consisting of a bundle of very thin wires of very soft iron is most effective.

More will be said about induction and other coils at some later time.

84. Echoes and Their Avoidance.

In the transmission of alternating currents over electric light and power lines the lines, as a rule, are not sufficiently long to permit the development of electrical waves. The frequency is low in comparison to the frequency or frequencies met in the transmission of speech. The frequencies in power transmission remain below 100 cycles per second. The frequencies of importance in telephony have a considerable range, say from 200 to 3000 cycles per second, 750 to 800 cycles per second representing a fair average, and at this frequency the telephone receiver is most sensitive.

The length of telephonic waves depends on the condition of the line, that is, on its resistance, inductance, leakance and capacity. By leakance is understood the coefficient of leakage usually denoted by "g." However perfect a circuit is constructed, there will always be some leakage through the insulating material, in many cases this leakage may be so small that it becomes negligible, but in long distance lines its existence can not be neglected. The leakage conductance, that is, the leakance g, is the reciprocal of insulation resistance and is conformly expressed in mhos per mile or kilometer.

In any line there is attenuation, which means that the effective value of e. m. f. and current diminishes the farther we progress from the source of energy. The attenuation of the line depends on the frequency; it increases with it. Hence in telephonic transmission, where waves of complex harmonic frequencies are propagated over the line, there will be distortion of the waves, because upper harmonics will be attenuated more vigorously than the lower frequencies. This results in distortion of speech which will be noticed in long distance telephonic transmission as defective articulation. Professor Pupin in his paper on wave transmission over non-uniform cables and long distance air lines shows that increasing the inductance of the line by the introduction of inductance coils at periodically recurring points obviates this difficulty. But the introduction of such coils causes wave reflections and the coils must be placed so that the detrimental effects due to these reflections will not neutralize the beneficial effects derived from the increased inductance.

Reflections, however, do not occur only in loaded lines, but on all lines, loaded or unloaded, whenever the line is not infinitely long or when receiving apparatus is connected to the line, or when the line is composed of several parts of different character, as for instance of partly cable and partly open wire, or also at points where the line splits up into branches, in short at all such points where the construction character of the line changes, reflections occur of more or less influential nature. A part of the wave traveling along the line when it reaches the change in character is reflected and travels back towards the sending end, being attenuated in the process. Arriving at the sending end it is reflected again. This process continues until the steady state of transmission is produced. In open wire circuits only a few hundred miles long this steady state is established very rapidly and the reflected currents are not noticeable; in very long circuits, however, the reflected currents become noticeable and may be heard at the distant end as distinct echoes, whence the name "Echo Currents," which may also be heard by the talker.

The echo effect becomes prominent to a remarkable degree on lines containing repeaters, and often become quite serious. The fact that the circuits are electrically very long makes the time lag of the echoes appreciable. At the same time, the repeaters overcome the high attenuation of these long lines and thus make the echoes louder. The seriousness of the effect is a function of the time lag and the volume of the echoes relative to the direct transmission. Therefore, it becomes of momentous importance to reduce the time lag. A. B. Clark in his paper on "Telephone Transmission Over Long Cable Circuits" (Transactions A. I. E. E., February, 1923) says: "A four-wire circuit 1,000 miles long has been set up in which the balances at the two ends were deliberately made poor so as to exaggerate the effects. More than a dozen successive echoes could be heard before they became inaudible. Since for each echo the voice energy traveled 2,000 miles this energy must have traveled the distance around the world before becoming inaudible.

In order that a circuit will be satisfactory for regular telephone use, the echoes must be kept small as compared to the direct transmission. Evidently if the first echoes are small as compared to the direct transmission, the later echoes will be much smaller in magnitude. For example, if the power in the first echo, heard by the listener is 1/10 as great as the directly transmitted power, the second echo will have only 1/100 as much power, the third echo 1/1000, etc.

The velocity of an extra light-loaded circuit is approximately 20,000 miles per second, while the velocity with medium heavy loading is only 10,000 miles per second. It is thus seen that the time required for voice energy to travel from one end to the other of an extra light loaded circuit 1,000 miles long is 0.05 second. An echo traveling from one end of the circuit to the other and back again would, therefore, arrive 0.1 second behind the impulse which started the echo. With medium heavy loaded circuits these times are of course doubled.

This shows that the irregularities become less noticeable the more rapidly the transmission takes place. It has been found that in long open wire lines with repeaters the current is transmitted more uniformly without loading. A non-loaded cable circuit consists principally of resistance and capacity, therefore the efficiency of transmission varies considerably with varying frequencies. Loading improves the efficiency as thereby the variations are reduced. On very long cables with repeaters light loading is best; with less inductance per mile a higher velocity of transmission is obtained and consequently a weakening of the echo currents, hence the use of extra light loaded cables for very long repeatered cable circuits. For comparatively short stretches a medium heavy loading is permissible, as the number of repeaters is smaller and the attenuation less.

Clark mentioned above the balances at the two ends of the circuit having been made deliberately poor. Every telephone man knows that a line in order to talk properly must not only be built uniformly but also that all apparatus separated on the line must be so arranged as not to disturb the uniformity of the electrical characteristics of the line, with other words *the line must be properly balanced*. He also knows that any line must permit of conversation being carried on both ways. Now the repeaters on long lines consists principally of vacuum tubes and therefore work one way only, in the opposite direction they are impenetrable. Therefore to assure two-way operation two circuits are necessary, one to talk in one direction and the other one to talk in the opposite direction, thus obtaining a four-wire circuit of the so-called 21 type,

Comm Ba

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The latest Monarch Type Universal Common Battery Switchboard installed in a new fire-proof exchange building at Colby, Wisconsin. This new switchboard was cut into operation on May 25th and the management of the Colby exchange is very well pleased with the operating efficiency of the new board.

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New Unit Position Sectional Type Switchboard

IN adopting the Monarch Unit Position Sectional Type Switchboard for their exchange at Colby, Consolidated Telephone Company of Wisconsin realize that the service they render is dependent very largely upon the efficiency of their exchange equipment.

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This switchboard is made up of individual sections, each having separate positional wiring, and specially engineered to meet the requirements of the exchange it is to serve. The flexibility of the unit position sections will adequately provide for any amount of expansion.

A single panel calculagraph section similar to the other sections can be placed in the most convenient location of the switchboard line-up and one can be placed at the growing end of the board for mounting the overhang multiple of the line equipment.

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Galvanized grounds, driven into permanent moisture, or where the surrounding soil is treated with salt or copper-sulphate to reduce its resistance, rust away rapidly.

Moisture or soil treatment does not shorten the life of Copperweld Ground Rods—the protecting outside layer of pure copper, permanently and continuously molten welded to the rigid steel core insures a low resistance ground connection for the life of the line. Furnished in one piece, pointed for driving.

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Products Include
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which means two-way, one element. It is, however, possible to obtain two-way talking on one metallic circuit by an arrangement called the 22 type (two-way, two elements), which has been fully described by Gherardi and Jewett in a paper before the A. I. E. E., an account of which was given in TELEPHONE ENGINEER in 1920. It would lead too far to describe this arrangement here, the reader is referred to above paper for detailed information, we repeat only the outline of the circuit in Fig. 98, which shows the line west and the line east, with the repeater between them. This circuit giving two-way transmission over one pair of wires is called a duplex bridge circuit, because the two arms containing the repeaters are not connected directly into the line for the reason that if they were, the currents coming from

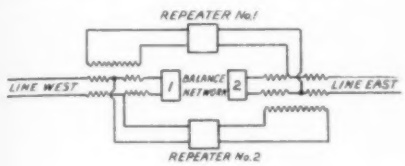


Fig. 98

the line west, for instance, would be amplified in repeater No. 1 and react upon repeater No. 2, where they would be amplified still further and be transmitted again to repeater No. 1. Such a continuous amplification would bring about a "singing" condition and a tendency towards distortion. To avoid this the line and the repeater branch are connected by a bridge, consisting of the line with its balancing network and an output transformer; the bridge to line west, for instance, prevents the currents coming from repeater No. 2 to react upon repeater No. 1.

We are just now interested in the balancing network. This network has the purpose to balance the line, and consists of a combination of resistances, induction coil and condensers which forms an artificial line in every respect simulating the electrical characteristics of the actual line.

Having learned how to reduce the time lag of the echo, means have to be found to reduce the volume also. The magnitude of the echo for a given irregularity depends upon the over-all transmission efficiency of the circuit. Therefore the remedy is to decrease the amount of irregularities. The taking out of the loading coils in the open wire long distance line with repeaters was a step in that direction.

85. Prevention of Unbalances in Toll Cables.

The tendency of the times is to get away from heavy open wire leads for toll and long distance lines. Cables along the Atlantic seaboard from Boston to Washington have been in use for years. At the present time, where the repeater has been perfected so that long lines can be operated without distortion of the telephone current, and, moreover, cables can be used with a much smaller gage wire than in the earlier construction, this network of toll cables is being extended all over the country. One of the most important requirements in this connection was the design of toll cables so as to obtain as nearly perfect symmetry in the arrangement of the two twisted wires in a pair as well as of the two pairs twisted together to form a quad.

In a cable a comparatively large number of circuits run close together over long distances. The currents in the pairs affect each other particularly at repeater points, where not only the currents themselves but also any crosstalk currents are amplified. Crosstalk, or rather its intensity, depends on the couplings of the lines, which requires an accurate transposition to obtain the just mentioned perfection of symmetry.

The comparative coupling of a system of four wires can be expressed as four partial capacities arranged on the lines of a Wheatstone bridge, which have to balance each other to prevent crosstalk. In practice this can be obtained by connecting the cable sections of the line in such a manner as to balance the capacity unbalance of a circuit in one section by the capacity unbalance in the opposite sense in the section to be connected. To this end the wires in consecutive cable sections are so joined to each other as to render the capacitive couplings in the in-

Fig. 99

dividual loading coil sections or fields as small as possible. This method, however, does not lend itself to a very good balancing, as the possibility of obtaining a fair balance is limited in cables with a small number of pairs. Furthermore, it is rather difficult to test and maintain such cables as the numbering of pairs and quads is different in different sections. In case of trouble joints will have to be opened and re-cross connected for a new balance. To avoid these difficulties an European cable manufacturer has developed a method of balancing which he calls the "condenser balance," whereby the couplings in the loading coil sections are corrected by addition of condensers of proper size. This method is illustrated in Fig. 99. The upper picture shows the small oblong condensers partly bundled, partly hanging down loose for working on testing. The lower picture shows the cable joint complete before it is enclosed by the casing.

Great improvements have also been made in the construction of the loading coils, the most conspicuous improvement being the substitution of powdered iron cores for the iron wire cores.

Development Body Urges British Telephone Need

London, Eng.—The business world of London was prominently represented at a recent conference of the Telephone Development association in this city. There is probably no single aspect of commercial life which is not fundamentally affected by improved communications, and the telephone plays obviously a very important part in this respect. A very timely allusion was made at the meeting by Lord Daryngton, better known under his former name of H. Pike Pease, to the value of advertising by the Post Office in order to create a greater demand for telephones.

It was stated that there are only 31 telephones installed per thousand inhabitants in the British Isles, as compared with 150 in the United States, 95 in Denmark and 66 in Norway. It is always a moot point whether a bold provision of telephone facilities would not itself create a more rapid demand. No doubt treasury officials might regard such a step as savoring of speculation, but as the use of the telephone benefits trade of every kind, the advisability of supply of exchange lines keeping, probably only for a short time, ahead of immediate requirements, should not be judged merely from the standpoint of immediate revenue for the Post Office, because the encouragement of business by better and more numerous inter-communications operates otherwise powerfully in favor of public revenue.

W. J. O'Connor Drafted by A. T. & T. from Southwestern

St. Louis, Mo.—W. J. O'Connor has resigned as vice-president in charge of publicity and public relations for the Southwestern Bell to become associated with Arthur W. Page, vice-president of the A. T. & T. at New York. At St. Louis Mr. O'Connor will be succeeded by Vincent M. Carroll as press representative with the title of assistant to the president.

How to Read Telephone Circuit Diagrams

By DAVID S. HULFISH

CHAPTER IX

That the different parts of a drawing or diagram may be referred to definitely, identifying the part without possibility of error, labels sometimes are placed upon the drawing. These labels may consist of words, letters or figures. Usually a "leading line" extends from the label to the part to which the label pertains. This system of labels is common wherever a written description accompanies the drawing or diagram, and is universal in patent office drawings. Fig. 548 is an excerpt taken from a patent.

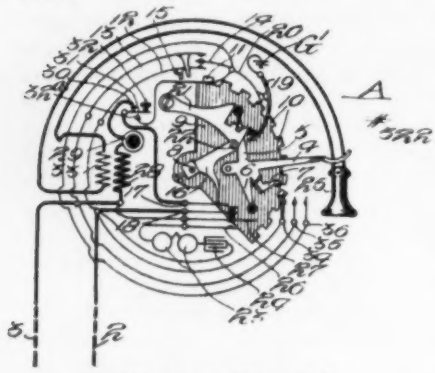


Fig. 548. Patent Office Labels.

Fig. 549 presents a detailed wiring diagram for a pair of plugs upon a common battery switchboard of a specific type. Accompanying the wiring diagram, at the top of the figure, is the skeleton diagram.

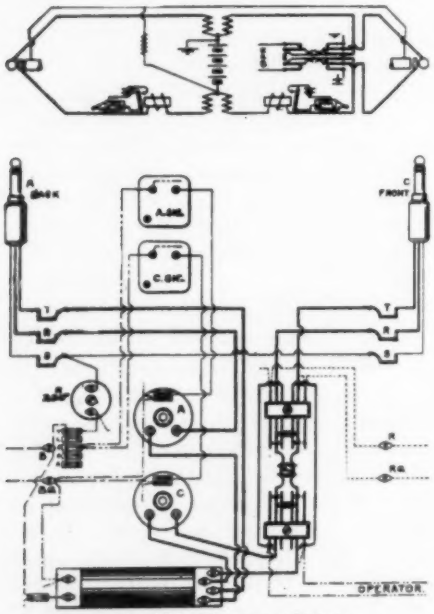


Fig. 549. Wiring Diagram, with Skeleton.

From the skeleton diagram it is seen that the two plugs are connected through a repeating coil which feeds current to the talking conductors; that a double-action key rings upon the calling plug or permits the operator to listen upon the pair; that mechanical visual signals are used and that they are displayed continuously while current is flowing to the talking conductors; that the bodies of both of the plugs are connected to the main battery, presumably for busy test purposes.

The wiring diagram shows that the answering plug is behind or "back" of the calling plug; that each plug is connected by a flexible cord to a set of three terminals, marked *T, R, S;* that in the connecting rack of the switchboard where the cords are attached the tip terminal is top, the ring terminal is middle and the sleeve terminal is at the bottom of the set of three. It shows that the two supervisory relays are mounted one above the other, the answering-plug relay being the upper one; also that the two signals are similarly mounted and related; probably also the signals are higher in the switchboard frame than the relays. It shows also many fuse mounts and fuses which are not indicated in the skeleton, and many terminals. The terminals are accompanied by labels indicating their use, and those labels probably would be found stamped in the switchboard adjacent to the respective terminals; this is true also of the labels adjacent to the fuse mounts, and upon the relays, and signals.

Many details of the wiring of the switchboard are disclosed very definitely when the coding and branching of the conductors are studied carefully.

The talking wires are drawn heavy, according to code *a* of Fig. 533. The respective terminals of the repeating coil are identified by the locations of the terminals, and the same is true of the relays and key terminals. The view in the wiring diagram of the relays *A* and *C* is taken such that the terminals are fully identifiable; the remaining characteristics of the relays are unimportant to installing or supervising the wiring. The function of the relay is left to the skeleton diagram.

The battery connection for the repeating coils extends from the terminal *B* to the fuse of the cord pair illustrated, thence onward to other similar fuse mounts, as is indicated by the *c* code line branching downward.

The ground connection to the repeating coils extends from terminal *BG* to the repeating coil terminal and then branches downward in *d* code line to other similar terminals.

The fuses *T* (test), *L* (line signals), *S* (supervisory signals), *O* (operator's telephone current supply), and *A* (alarm circuit) are connected to the *B* battery terminal.

From the test fuse *T* leads a 'bus wire in *f* code to the resistance coil and continuing to other similar coils. From each of the resistance coils an individual signal wire (*b* code) leads first to the sleeve terminal of the answering plug, then to the sleeve terminal of the front or calling plug. The diagram shows therefore that each plug pair has its own resistance for test.

From the fuse *S* two 'bus signal wires (*f* code) extend to the answering and calling signals respectively, each serving all of the answering and all of the calling signals of the switchboard, respectively.

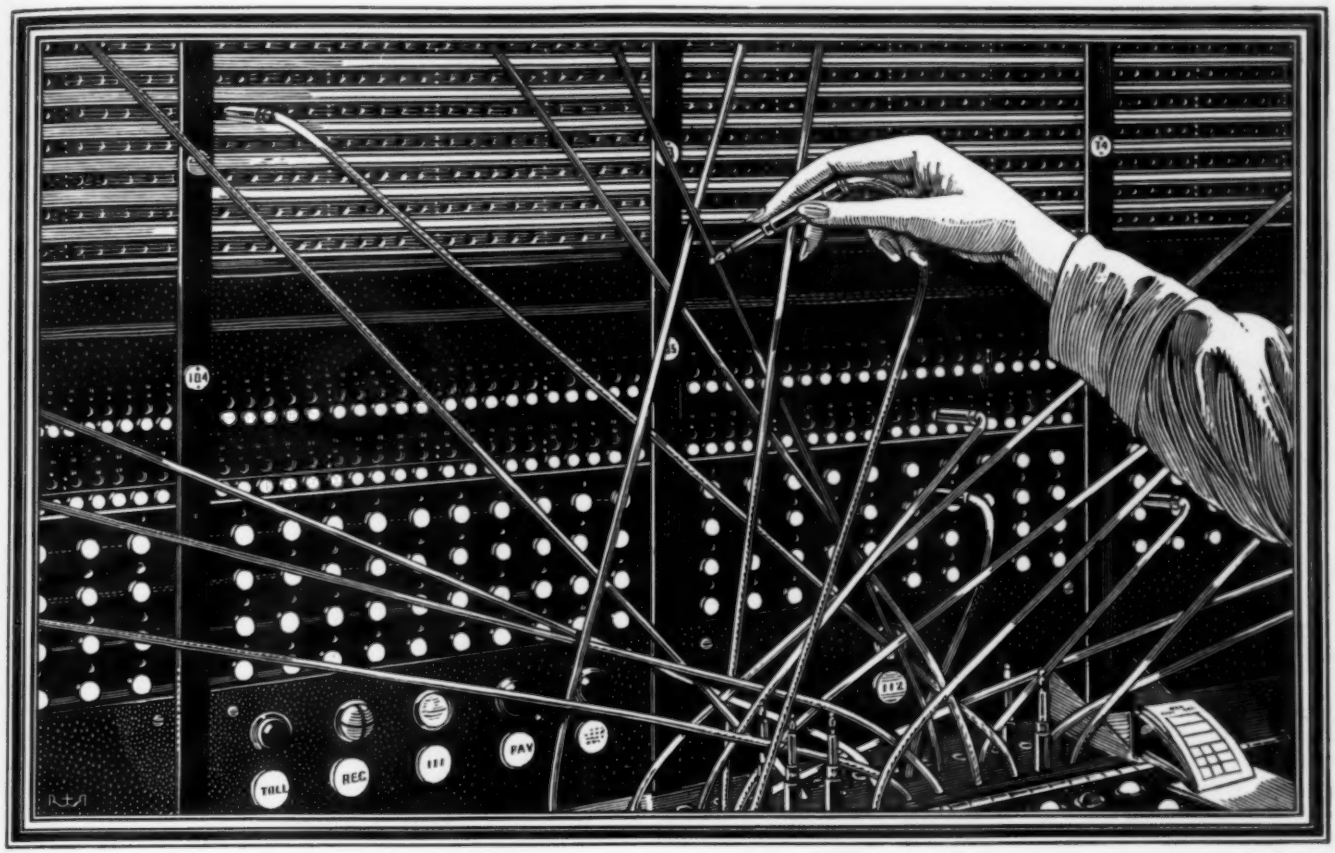
In the relays *A* and *C*, a 'bus wire from the terminal *BG* serves all of the *A* relay contacts and a separate wire serves all the *C* relay contacts.

The *A* relay contact is connected to the *A* signal by an individual signal wire (*b* code); the same is true of the *C* relay contacts and the *C* signal.

The ringing 'bus wires (*e* code) are brought from the power board to the terminals *R* and *RG*. Thence, the pair is taken to the indicated terminals of the key illustrated and then to the analogous terminals of similar keys.

The operator's circuit, in the lower corner at the right, is drawn in *f* code, indicating a common signaling circuit. While these wires carry speech currents, they do not carry speech currents between subscribers in conversation. For this distinction, they are drawn in *f* code rather than in *a* code. The operator's circuit also passes from key to key, as indicated by the branching wires at the terminals of the key illustrated.

The wires from terminals *B* and *BG* to the left and to the power board, and from terminals *R* and *RG* to the right and to the power board, will be found



The Switchboard

An Advertisement of
the American Telephone and Telegraph Company

A WEB of cords plugged into numbered holes. A hand ready to answer signals which flash from tiny lamps. A mind alert for prompt and accurate performance of a vital service. A devotion to duty inspired by a sense of the public's reliance on that service.

Every section of a telephone switchboard typifies the co-ordination of human effort and mechanism which makes possible America's far-reaching telephone service. Its cords link for instant speech those who are separated by a few miles or by a continent. Its guardian operators are of the telephone army—men and women vigilant to meet a nation's need for communications.

In plant and personnel, the Bell System is in effect a vast switchboard serving a nation that has been transformed into a neighborhood through telephone growth and development.

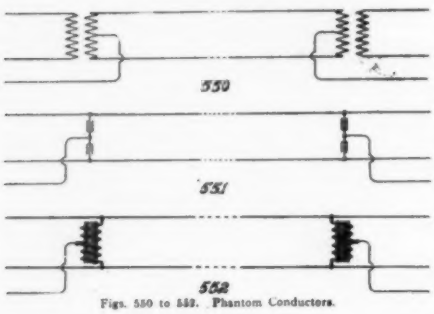
in detail in the power plant wiring diagram.

The wires connecting to the line-signal fuse *L* will be found in detail in the wiring diagram of the line circuit.

The extension of the circuit marked *Operator* will be found on the wiring diagram of the operator's circuit, in which circuit diagram will appear also the fuse *O* and its proper connections.

The fuse *A* and the unconnected terminals of the signals *A* and *C* will be found provided for fully in the wiring diagram for alarm circuits.

It is possible that for some switch-



Figs. 550 to 552. Phantom Conductors.

boards all the circuits of the switchboard may be represented in a single complex wiring diagram, but the separation of the wiring diagram into parts is the form most likely to be encountered.

The "phantom circuit" is the name given to a derived circuit upon a telephone line, the system of connection of the principal and derived circuits being such that the instruments of the principal circuit are unresponsive to currents flowing in the derived circuit, and the instruments of the derived circuit are unresponsive to currents flowing in the principal circuit.

The phantom in one of its forms may be understood from Fig. 552 when studied in conjunction with the principle of the Wheatstone bridge. When the Wheatstone bridge is adjusted to a balance, the galvanometer is unresponsive to currents in the battery circuit. The wires between the two ends of the bridge might be lengthened indefinitely, and a dozen galvanometers might be connected, yet this would be true. In Fig. 552, such a modified bridge arrangement is shown. The ratio-arms are at the left, the battery circuit entering at the middle; the resistance-arms are at the right, with the battery circuit leaving at the middle. Telephone sets connected between the two line wires of this circuit arrangement would have a circuit relation similar to the galvanometers across a balanced Wheatstone bridge, and would be unresponsive to any currents passing in the battery circuit. By using the "battery circuit" as a telephone wire, a "phantom circuit" is attained.

For convenient discrimination, the terms "phantom circuit" and "physical circuit" are used.

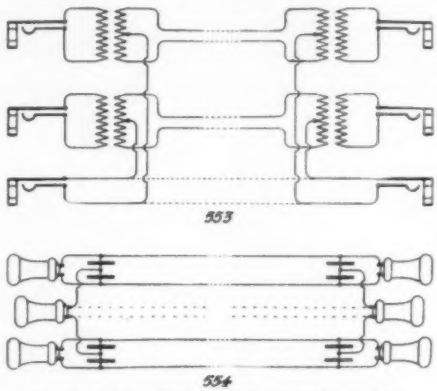
There is no symbol for the phantom as such. It is a circuit system, traced through such symbols as may be required to represent the apparatus going to set up the system of the diagram.

Fig. 550 shows a phantom formed with repeating coils; Fig. 551 shows a phantom with condensers; Fig. 552 shows a phantom with retardation on coils. Figs. 553 to 557, inclusive, show some applications of the phantom circuit to practice in telephony.

Fig. 553 shows two physical circuits connected as two trunks between two switchboards. The derived circuits of the two physical circuits are used to form a metallic circuit phantom, being the equivalent for commercial purposes of the dotted conductors suggested at the bottom of the figure.

In Fig. 554 two condenser phantoms form a metallic circuit phantom.

In Fig. 555, telephone and telegraph circuits are shown working simultaneously over a single pair of wires, the telephone circuit being a metallic circuit



Figs. 553 and 554. Metallic Circuit Phantom Telephone Lines.

and the telegraph circuit being a grounded or earth return circuit.

Fig. 556 shows a telephone trunk circuit between two switchboards in which the lamp signals are operated over the phantom of the trunk. The depression of the key at either end of the trunk will operate the lamp at the distant end until the distant key is operated also or the home key restored.

In Fig. 557 a circuit is shown in which the phantom of a subscriber's line is used as a circuit for supplying his transmitter at the substation with current from the central office battery. The battery, supply circuit is traced from earth through the battery, through the right-hand relay to the middle of the line side of the repeating coil, thence over the "phantom," or both wires of the line in parallel, to the secondary of the induction coil of the substation telephone; thence through the two windings of the receiver to the hook switch and to the upper junction point in the primary circuit of the telephone, through the primary winding of the induction coil and the transmitter to earth. The substation condenser is charged by the potential difference across the primary and transmitter, and its charge varies with the resistance of the transmitter. Variations in the volume of charge in the condenser are obtained by direct charge over the phantom of the line and by discharge through the primary of the induction coil. These fluctuating currents through the primary cause induced currents in the secondary, which induced currents are transmitted over the two wires of the "physical" line and through the repeating coil at the central office to the jacks of the central

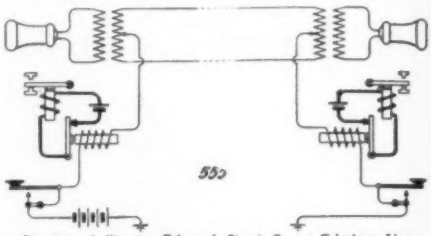


Fig. 555. A Phantom Telegraph Circuit Over a Telephone Line.

office switchboard, the energy thus transmitted over the physical circuit being non-interfering with the steady feeding of the current over the phantom circuit.

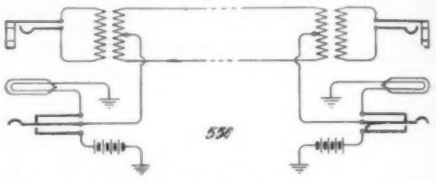


Fig. 556. A Signal Circuit Working Over the Phantom of a Telephone Line.

When reading the circuit of Fig. 558, which shows a system of composite telegraphy and telephony, it is necessary to keep in mind the electrical constants of the various parts of apparatus. There is no new symbol for any part of the apparatus involved in this diagram, but there is involved a principle which is met in many telephone circuits. This is the division of currents unequally among derived paths.

By "derived paths" is meant paths which each will take a portion of the

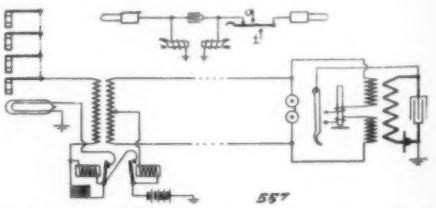


Fig. 557. A Common Battery Transmitter Fed Over the Phantom of the Telephone Line

total current which at some point flows over a common path. Where the sources of current are sources of constant potential only, the derived paths will take currents which are inversely proportional to their resistances. Where currents of varying frequency are involved, such as telephone speech currents, the current may not divide according to the law of resistances.

Where telephone speech currents and constant-potential currents, as from a battery, flow at the same time over the same wire, and then encounter a set of branching circuits, it is not at all an obvious conclusion that they will divide into the derived circuits in the same proportions for each of the possible paths. Each path must be examined for evidence of its electrical constants, such as resistance, inductance, potentials and capacity. It may be found that, of a pair of branches leading from a main line wire, one of the branches will take the lion's share of the speech currents of the line, and the other branch will take the lion's share of the battery currents of the line, although one line-conductor has been carrying both kinds of current harmoniously up to the point of branching.

Inductance connected in series with a conductor opposes the passage of telephone voice currents with far greater effectiveness than it opposes the passage of currents from a source of constant

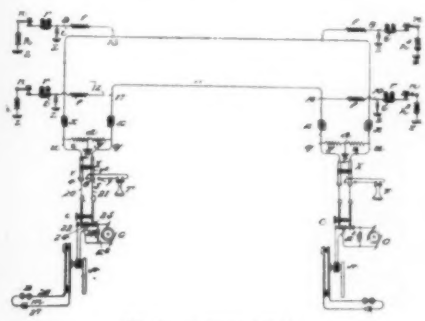


Fig. 558. Composite Circuit.

potential, or such currents as the intermittent currents of a telegraph system.

On the other hand, a condenser connected in series in a conductor will oppose the battery currents of telegraphy most effectively, and will oppose the telephone speech currents with but little effect.

By taking advantage of these characteristics, it is possible to construct a pair of derived paths, in series with a line wire, such that one of the paths will carry substantially nothing but telegraph currents and the other path nothing but telephone currents. Such a system renders possible simultaneous telegraphy and telephone over the same line conductors, and it bears the name of "composite" telegraphy and telephony.

Fig. 558 shows a circuit diagram of a composited line. The line conductors *V* and *W* branch at the points *13* and *17* at the left and *14* and *16* at the right.

The telegraph circuits may be traced easily. Beginning at the upper left-hand corner of the diagram, at earth symbol *Z*, proceeding through battery *h*, key *n*, telegraph relay *r*, conductor *9*, and inductance or highly inductive resistance *f* to the junction point *13*, we may trace to the left from the junction point until the condenser *x* is encountered; as current from the battery *h* cannot flow through the condenser *x* which has been encountered, all current from the battery *h* must flow from the junction point *13* to the right and over the line conductor *V* to the junction point *14*. From the junction point *14* to the right and downward a condenser *x* is encountered, stopping the battery current, so all battery current coming over the line wire *V* must follow the branch path upward and to the right from junction *14*, through inductance *f*, conductor *8*, telegraph relay *r*, key *n* and battery h_2 to earth at symbol *Z*. Note that the two batteries which are included in this circuit, namely, battery *h* and battery h_2, are indicated as having grounded their poles of opposing polarity, so that the potentials of the two batteries are added in producing a current in the line conductor. The telegraph current does not flow through the condenser *i* from conductor *8* to earth, nor from conductor *9* to earth.

In like manner, the telegraph circuit over line conductor *W* may be traced from earth at the left over the elements *h, n, r, f, 12, 17, W, 16, f, 10, r, n,* h_2 to earth. In this circuit also the branches to the condensers *x, x, i* and *i* are encountered, but none of these branches can carry current from the batteries *h* to h_2.

The two telegraph circuits traced are independent of each other, and may operate simultaneously and without interference.

Tracing now the path for speech currents, these must originate in one telephone *T* and terminate in the other telephone *T*, each of the symbols *T* and *T* being taken to represent a complete talking equipment. With the switches *X* and *X* at left and right, both considered as with their levers shifted to the right, the two telephones *T* and *T* are connected to the line conductors *W* and *V*.

Starting from the telephone *T* at the left, trace both conductors of the line at the same time. Passing through both levers of the switch or key *X*, and over conductors *u* and *q*, junction points are encountered which offer paths through resistances *z* and *y* to earth. While the symbols of these resistances do not specifically indicate that they are of high inductance, it seems necessary to assume that they are such, and that there is no appreciable leakage of the telephone voice currents through them, either from wire to wire of the line or to earth.

Next, the two condensers *x* and *x* are encountered, but these offer no opposition to the passage of the speech currents. When the junction points *13* and *17* are reached in the two line wires, two more branch paths to earth are encountered, but the formidable inductances *f* and *f* tell the defeat of any speech currents attempting to escape over those branches.

Substantially, the total quantity of speech current output of the telephone *T* at the left therefore reaches the line conductors *V* and *W* passes over those line conductors to the apparatus at the right. Here, again, are encountered, first, the earth branches containing the blockading inductances *f* and *f*, then the friendly condensers *x* and *x*, then the ineffective resistances *y* and *z*, then the switch *X* and the telephone *T*.

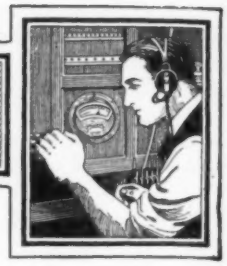
The telephone current has been unable to flow through the telegraph instruments, either effectively or wastefully; nor have the telegraph currents been able to flow through the telephone circuits. The two telegraph circuits and the one telephone circuit are operating harmoniously and without interference, simultaneously, upon the single pair of line wires *V* and *W*.

The efficiency of the condensers and inductances in shutting out the telegraph and telephone currents, respectively, is not so great but that some little leakage occurs. For this reason the small condensers *i i i i* permit to waste to earth such telephone currents as leak through the inductances *f f f f*, and the inductances *z y y z* permit to waste to earth such telegraph energy as may leak through the condensers *x x x x*.

In this circuit, ringing upon the telephone pair with a ringing generator of slow pulsations might send such heavy currents over the line conductors as would rattle the telegraph relays in an objectionable manner. To obviate this the ringing generators *G* and *G* at left and right, for signaling over the telephone circuit of the composite line, are made of very high frequency. By the operation of either key *c* at right or left of the diagram, the current from the high-frequency generator is passed over the line conductors, and because of its high frequency it passes through the condensers and is obstructed by the inductances, as the circuit was traced for the telephone speech currents. At this time, however, when the ringing signals are being sent over the telephone line, the keys *X* and *X* are in their left-hand positions, as shown in the diagram, and the ringing current received at either end will pass down through the closed key *c* and through the helix of the relay *A*. The relay *A* formed the subject of Figs. 333 and 334, the former being a detail view and the latter a symbol. It is a relay especially designed for response to currents of high frequency, and by its action the ringing signal is announced upon the signal device *B*.

Bellevue, O.—Frank A. Knapp and associates have bought the New Ashley Telephone Co.

LINE AND DESK



DESIGNS "PINCH HIT" DESK SETS

While cutting over a new automatic exchange it was found that there were a shortage of desk type telephones and that thirty-five wall type telephones must be used on desks. After much argument a bracket was designed as shown in the

This tilted mounting made a desk set

accompanying photograph which answered the purpose temporarily. It was suggested that we equip these brackets with wheels and four wheel brakes, but we didn't take the suggestion seriously.—By Ray Blain.

HUGE MAP FOR CIRCUIT LAYOUT

As the economical conduct of any business is dependent upon a system of adequate, accurate and up-to-date records, so the economical use of a large telephone and telegraph plant requires a somewhat elaborate scheme for recording the kind and amount of use made of the various facilities, as well as for directing changes to be made in such use. The Long Lines has over 610,000 conductor miles of open wire and 1,210,000 conductor miles of cable used for the handling of its telephone and telegraph business. In addition, there are 136,000 circuit miles of open wire phantom circuits, 281,000 circuit miles of cable phantom circuits, 70,000 channel miles of carrier telephone circuits and 300,000 channel miles of carrier telegraph circuits. The number of telephone and telegraph circuits assigned to these facilities are as follows:

Telephone.		Telegraph.	
Message circuits.....	3,950	Morse.	1,035
Full talking circuits..	363	Printer	113

These figures do not include circuits used in the telephotograph and broadcasting services, nor the telephone order circuits or telegraph test wires used for maintenance purposes.

For circuit layout purposes, the open wire facilities are recorded on a wall chart 40.5 feet by 7.5 feet, and the cable facilities are recorded on fifty-six swinging charts, totaling 928 square feet. The gauge and loading of the facilities are indicated. The telephone and telegraph circuit assignments are recorded in lead pencil in order that alterations may readily be made, as orders for circuit layout changes are issued. Supplementing the chart records is a toll circuit layout card record showing the detailed makeup and necessary transmission information for each telephone circuit. There is also a card record showing the routing and method of operation of each telegraph circuit.—R. J. Wolf in Long Lines.

SOLDERED LINE JOINTS CURE NOISY TRANSMISSION

We had considerable noisy transmission trouble with a lead of three circuits rural and one circuit toll. These lines all went down in the sleet storm of Feb. 22, 1922. After we rebuilt the lines using as much of the old wire as we could and being very careful to make good joints, we found the lines very noisy, owing to a high voltage electric line carrying 33,000 volts on the opposite side of the road. We tested the lines for grounds and found the lines clear of all grounds. We then came to the conclusion that we had high resistance joints, and rather than test each joint separately we decided we would solder each joint.

We therefore built a platform on a wagon, the top of which was high enough so a man standing on the same could reach the wire conveniently. We then drove this wagon under these leads with soldering equipment and soldered each and every joint, being sure that the soldering irons were hot enough so solder would run into joint and make good connection, the joints were then well wiped to remove acid.

There was an immediate improvement in the transmission. The noise was reduced to a minimum and the lines talked up clear and distinctly. Of course it is understood that lines paralleling high power lines will never be as quiet as lines not so exposed, but our experience has been that much of the noise may be eliminated by good soldered joints and in our case it certainly paid well for our trouble and expense.—H. W. Hoffman, Stockbridge, Wis.

THE PLANT JOB TODAY

That the job of the plant man is becoming more and more exacting was well illustrated by Mr. P. L. Johnson of the New York Tel. Co. in a recent paper before the New York Telephone convention. Mr. Johnson said in part:

"Plant work is very much the same today as it always has been with the exception that the requirements are a lot more exacting. Telephones are no longer installed with the idea that they shall be suitable for local use only, but must be installed with the idea that they will from time to time take part in very long distance and even transcontinental conversations.

"These more severe requirements make it necessary for the telephone companies to exercise their ingenuity and engineering ability to improve their plant without incurring a corresponding increase in cost. Also, the public is more exacting than it formerly was and the telephone companies must make constant efforts to improve the service by quicker installations, more rapid clearing of troubles that develop, and courteous and efficient treatment of the subscribers by their employes."

NEW RECORDS SET IN 1926 BY WOOD-PRESERVING

The continued growth of the wood-preserving industry in the United States is clearly shown by the fact that in 1926, the latest year for which statistics have been compiled, more plants were in active operation, a large quantity of preservatives was used, and a greater amount of wood was treated than ever before." Thus favorably does R. K. Helphenstine, Jr., of the United States Forest Service, introduce the compilation of statistics of the wood-preserving industry for 1926, which has just been published by the Forest Service in co-operation with the American Wood-Preservers' Association.

These extracts of the report are taken from "Wood Preserving News."

Poles ranked first as showing the greatest increase over the 1925 total, this increase amounting to 7,306,675 cu. ft. The amount of creosote reported used in 1925 was increased by 10.7 per cent in the total given for 1926. The 1926 totals record a convincing increase of production in each of the seven classes of material, thus indicating that acceptance of preservative treatment as essential to ultimate timber service is general for all types of structural timber exposed to decay.

Preservatives

In 1926 the industry consumed 185,733,180 gal. of creosote, or 18,090,390 gal. more than was used in 1925, the rate of increase being 10.7 per cent. Of the 1926 total, 95,443,114 gal., or 51.4 per cent, was imported from England, Canada, Germany, Mexico, Japan, Belgium, and Holland, while the remaining 90,290,066 gal., or 48.6 per cent, was domestic creosote.

Poles

Again in 1926, as in 1925, poles showed the largest amount of increase, the total being 49,511,088 cu. ft., or 7,306,675 cu. ft. more than the total for 1925, and the per cent of increase being 17.3. The number of poles treated was 2,813,130. Pressure-creosoted southern pine poles recorded an increase of 145,681 poles, or 18.6 per cent, as compared with the 1925 total for this species, and pressure-treated Douglas fire poles registered a substantial increase for 1926.

Crossarms

The number of crossarms treated during 1926 surpassed the 1925 total by 1,166,024, an increase of 116.2 per cent, and the total for 1926 was 2,169,097. This item has shown a steady growth in volume since and including 1921, although the increase for 1926 is by far the greatest recorded for crossarms during the six-year period.

ONE LINEMAN OUTBATTLES FOUR THUGS

Four unmasked men made an unsuccessful attempt to hold up and rob Harry Casson, a lineman for the Bell Telephone Company, recently on the state highway between here and Mammoth Spring. As Casson was on his way to Mammoth Spring the men threw large rocks in the path of his car. When he stopped one of the men jumped on the running board and another on the back of the car. Casson, however, jumped out, pulled a gun on the desperadoes and they fled. He had $65 on his person. He was uninjured, but his car was damaged to the extent of $35.

"Hurrah for us old 'Hikers.' Some good stuff in us yet," comments J. P. Whitson, the well-known Arkansas telephone man, who sent TELEPHONE ENGINEER the news of Casson's exploit.

H. R. Billington Made Kellogg Phone Sales Manager

Chicago, Ill.—The appointment of H. R. Billington as Manager of Telephone Sales has been announced by the Kellogg Switchboard & Supply Co.

Mr. Billington comes to the Kellogg Company with a broad experience in sales and manufacturing in the telephone and allied fields; and with a keen understanding of present day telephone problems. Outside of the telephone field he has also an enviable record as an organizer and business builder.

Mr. Billington will devote his energies to the further expansion and development of the Telephone and Switchboard Sales Division, in connection with the progressive policies which are a part of the progress of W. L. Jacoby, president of the Kellogg Company.

British to Advertise in Telephone Booths

London, Eng.—The use of illuminated advertising signs in public telephone booths has been approved by the British Postmaster-General. Some 2,500 booths in London districts are to be equipped at once with a device displaying directly in front of the caller's eyes a succession of brightly lighted and colored adver-

You are invited to visit the

RUNZEL
-LENZ

Convention Headquarters

Room 118
Hotel Sherman

We'll be glad to see our old and new friends in the field again, and as usual will have on display a complete line of the finest telephone cords made.

Runzel-Lenz Electric Mfg. Co.

Specialists in the Making of Superior Telephone Cords

1751 North Western Ave. CHICAGO, ILL.

tisements, and later other booths throughout the country will be fitted with these machines.

The ads are set in motion as the caller enters the booth. Each sign appearing on the glass face of a box attached to the wall above the telephone measures three by four inches, and is displayed for about seven seconds, so that in the course of a three-minute call 24 signs will solicit the attention of the speaker. Should he have a second call the same series of ads would pass again before his eyes.

The Automobile Association of Great Britain has recently adopted an improved roadside telephone box for the use of its members.

Unique Sets Lively Pace in New Factory

Chicago, Ill.—A steady rate of progress has featured the history of the Unique Mfg. Co., Inc., makers of the Unique blow torches, burners and furnaces that are so extensively used in telephone work. The latest step in the climb of Unique's business was the move into the company's own factory building at 221 West Whiting street, conveniently located just north of Chicago's loop district.

Here Unique has two stories and a basement of the most modern type of daylight factory structure, equipped with the last word in machinery for the manufacture of the company's products. Among this equipment are many devices specially made for speeding up production of the Unique appliances. This investment in special production equipment has enabled the concern to keep step with the increased sales and at the same time maintain the high standard of the output. The output of the plant is given testing of a comprehensive and careful character before shipment. All tests are made under conditions that probably are more severe than actual working conditions. Each blow torch, furnace, or other burning device in the Unique line is filled with fuel and set into operation as the final detail of inspection. The tests are made under expert supervision and constitute a completely satisfying assurance of the performance of the appliance being tested.

W. R. Abbott Heads Bell Veterans

W. R. Abbott, president of the Illinois Bell Telephone Co., was elected president of the Telephone Pioneers of America

W. R. Abbott

at the 1928 annual convention held in Colorado Springs, Colo.

The Telephone Pioneers is the association of Bell telephone men and women who have been in the service twenty-one years or more. There are more than 10,000 members. Mr. Abbott, the new president, has been in the telephone service since 1889. He came to Chicago to enter the service of the Chicago Telephone Co., now the Illinois Bell, in 1895. He is a member and was the first president of Theodore N. Vail Chapter No. 1, which is composed of Illinois pioneers.

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THE TELEPHONE

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By H. C. DODGE

Vice President, Paul C. Dodge and Company, Inc.

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Studying Details of Telephone Work

By E. R. COLLINS
Wire Chief, Manitoba Telephone System

CHAPTER IX

Magneto Switchboard Signals

The use of the polarized bell, as a switchboard signal, as shown in Fig. 59, Chapter 8, is of advantage only in very small systems, where the operator devotes only part time to the telephone switching. Where large numbers of lines are grouped in a magneto system, the tubular drop is used as a signal. This type is compact, quiet in operation, provides a visible signal as well as an audible signal, requires very little current to operate it and is not subject to inductive disturbance from other coils.

Inductive Interference

When a current flows through the coils of an electro-magnet, the magnetic lines of force surround the coil in curved lines from pole to pole. These lines extend and draw in, as the voltage of the current rises and falls. In Chapter 3 Fig. 20 and 21, we showed experiments with iron filings to prove this. If you will refer to the magnetic pictures you made at that time, you will see that in Fig. 20 the lines spread a considerable distance all around the core of the magnet. In Fig. 21 there was a magnetic path provided from the one pole to the other, and the picture will show that the spread of magnetic lines is reduced to a very small area.

Now get two tubular drops, such as are used for the clearing out signal on a cord circuit. Remove the shell from the coil of each, and connect the coils as shown in Fig. 60. Use the oscillator described in Chapter 6, July issue, Fig. 42, and connect it to Coil "A." Connect an operator's telephone receiver to Coil "B." The tone from the oscillator will

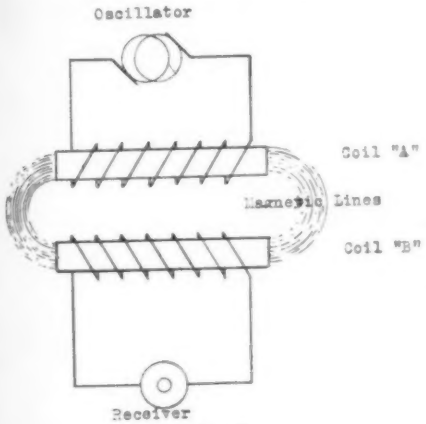

Fig. 60.

be heard in the receiver due to the magnetic lines from "A" cutting through the windings of "B." This tone becomes louder as the coils are brought close together, and when the coils are at right

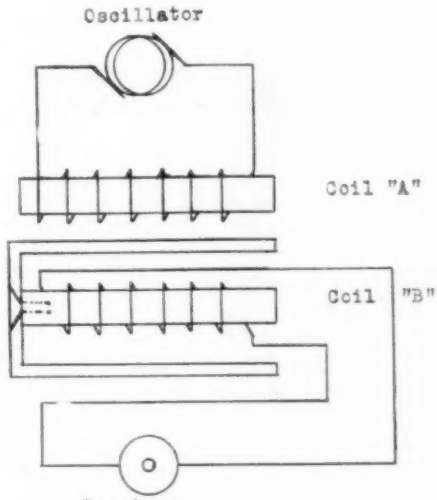

Fig. 61. Showing inductive effect with one coil shielded.

angles to each other, very little tone is heard.

In Fig. 61, Coil "A" is the same as in Fig. 60. Slip the soft iron shell over Coil "B," and repeat the experiment. In this case there will be very little if any

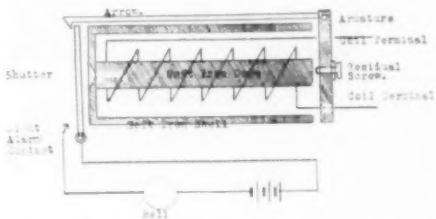

Fig. 62. Construction of a typical tubular drop.

tone heard in the receiver. The magnetic lines from "A" have found a low resistance path through the mass of iron in the shell of the Coil "B," and there has been no effect on the windings of coil "B."

Slip the shell over the coil "A" and remove the shell from coil "B" and the results will be the same. With the shells on both coils, the magnetic effect of one coil on the other will be nil.

In Fig. 62 is shown the cross section of a tubular drop signal. The soft iron shell completely surrounds the coil. With the armature in place, there is only the gap between the end of the shell and the armature, over which the magnetic lines must travel. When current flows through the coil, the magnetic lines will endeavor to lower the resistance of the field, and will draw the iron armature toward the shell, and the core of the coil. In our previous experiments we discovered that the smaller the air gap in the magnetic field, the greater the pull of the magnet. It should be quite plain therefore that this type of electro-magnet should be sensitive to very small current flow. These coils are usually wound with many turns of very fine wire, which makes them more sensitive to small currents.

The armature is suspended between two screws called trunnion or pivot screws. These must be adjusted to give the armature free movement, but must not allow it to change its position in regard to the pivot.

The arrow on the armature is made of brass or aluminum. The hook on the end holds the shutter so that it is just a little off the vertical position. The arrow of course will rise and fall with each pulling in and releasing of the armature.

Suppose there is a telephone generator in a telephone connected to the coil. The armature will pull in for each alternation, and release between alternations. If a 20 cycle current is flowing, then the armature and arrow will move 40 times a second. In some types of signals, the arrow extends through a hole in the plate which holds the shutter in place. When the armature pulls in the arrow hits the top of the hole just before the armature hits the core of the coil. This places a tension on the arrow, which acts as a spring, and as soon as the pull of the armature stops, the tension of the arrow will start the armature away from the core.

In some types, a brass screw, called a residual screw, is set in the armature, so that the brass hits the core. This prevents the residual magnetism of the core from holding the armature after it has been pulled in. Both methods make the armature quick to release and this gives a rattle, which acts as a good signal to the operator.

The screw which holds the coil in the

core is also of iron, and should never be replaced by a brass screw, as this would weaken the magnetic field to some extent. When the shutter falls, it closes a pair of contacts which can be used to operate a buzzer or bell to act as a continuous signal. This is usually referred to as the night alarm circuit.

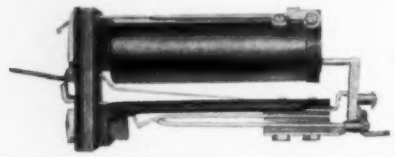

Fig. 63. Combination signal and jack with drop shutter.

In Fig. 63 is shown a cut of a typical combination drop and jack. Such a unit will serve one line. These units can be added to the switchboard as new lines are required. The coil of the signal is connected to the jack by the brass springs at the back of the jack. The normal contact of the jack serves to connect the coil to the line, and is opened when a plug is put in. This contact does not carry any voice currents, so a platinum contact is not always used.

Fig. 64 is another type of combination jack and signal. Here the signal con-

Fig. 64. Combination signal and jack with ball target.

sists of a ball, heavy on one side. The heavy side is held up by the arrow and when in this position the ball is black, to conform with the rest of the board. When the latch lifts, the ball rolls over, and shows a red or white to the operator, which shows up in sharp contrast to the black frame work of the front of the board. The contact of the drop coil is taken from the inner end, by means of springs. Removing one screw from the armature takes the coil out without unsoldering any connections.

Both types of signals are self restoring. When the operator puts her plug into the jack, the tip of the plug moves a spring to restore the shutter or ball. This spring is insulated with a piece of fibre insulation. This frequently becomes broken or worn out, and allows the tip of the plug to touch the frame of the signal. This would ground the line if the frames of the drops were connected to ground. If two such signals were defective, a talking circuit would be formed through the common framework to the tips of the two plugs. This trouble would only show up when such lines were connected. It is a very easy matter to connect a switchboard plug with a battery and buzzer, and check over a whole switchboard for such defective restoring springs. We will refer to this again.

The part of the jack where the plug is inserted is called the thimble. These are renewable, and should be changed if worn, so that the plug does not fit properly. In ordering thimbles, it is best to order them complete with bushings.

In Fig. 65 is shown a very common type of drop mounted on a strip. This particular type is used for a ring off signal for cord circuits. When a drop of this kind is used for a ring off signal, it will be connected across the line, all the time the parties are talking. The low resistance field due to the iron shell gives very high inductance. Therefore the

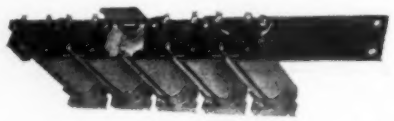

Fig. 65. Strip of tubular jacks used for cord signals.

impedance of this drop to voice currents will be very high, while to low frequency ringing current it will be low.

Switchboard Wiring

The wiring in a switchboard is sewed closely together in forms. It will be remembered that in Chapter 4, Fig. 25, we had two parallel wires laid on a table, and laced close together. It was found that when a current passed over one wire, it induced a current in the other

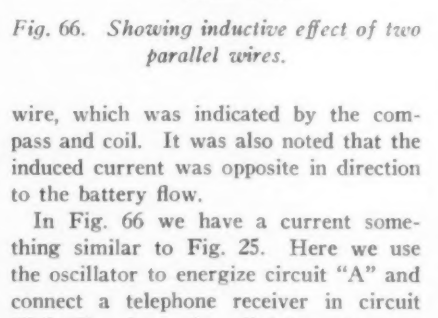

Fig. 66. Showing inductive effect of two parallel wires.

wire, which was indicated by the compass and coil. It was also noted that the induced current was opposite in direction to the battery flow.

In Fig. 66 we have a current something similar to Fig. 25. Here we use the oscillator to energize circuit "A" and connect a telephone receiver in circuit "B." The closer the adjoining wires are brought together, the louder the tone in the receiver. If the voltage in circuit "A" is strong enough, the lines of force will extend out past both sides of circuit "B." Therefore it will induce a current in both wires, opposite to the flow of circuit "A."

In Fig. 67 we have two parallel circuits, "A" and "B." These are fastened to the table or board with nails. The small circles indicate the nails. Now drive four extra nails ½ inch on either side of the center of the circuit, as shown in the drawing 67. Connect a non-

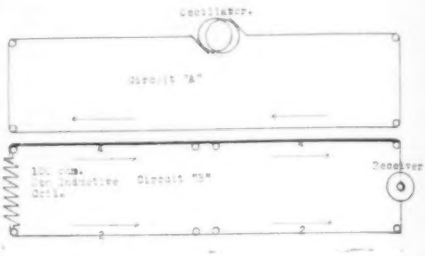

Fig. 67.

inductive resistance of about 100 ohms in one end of circuit B and a telephone receiver with a cord to the other end. We have shown one side of circuit "B" drawn heavy and one light for clearness in our explanation.

If there is a current induced in the heavy wire of "B" it must flow through the resistance and back over the other wire, and through the receiver.

If there is a current induced in the light wire it must flow around through the resistance over the heavy wire and back to the receiver. Now imagine these two induced currents starting out in the same direction, and observe that they

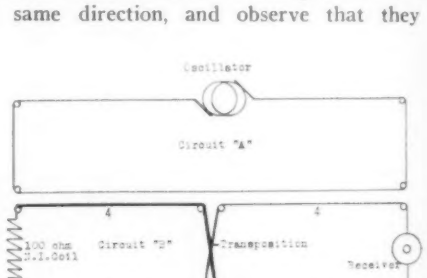

Fig. 68. Showing effect of transposing a pair of wires.

will be flowing against each other in the return half of their circuit. If they were both of the same strength, one would overcome the other, and there would be no sound heard in the receiver. But one wire is closer to circuit "A" than the other. Therefore that wire will have a stronger current induced in it than the other. Suppose the two sections of the heavy wire in "B" be given a value of 4, and the two sections of the light side a value of 2 since the induced current will be weaker than in the closer wire. If one current is stronger than the other, and they are opposing each other, then the sound heard in the receiver will be the difference between the two induced currents.

Add the values of the heavy line and we have $4 + 4 = 8$. Add the values of the light line and we have $2 + 2 = 4$.

Subtract and the difference will be 4, which will be the value of the sound heard in the receiver.

In Fig. 68 we have crossed the two wires over at the four nails in the center. We have divided each side of circuit "B" into two equal sections. Now we have one-half of the heavy line, and one-half of the light line closest to circuit "A," and a similar arrangement for the other side of "B." If we give the two sections closest to "A," the value of 4 each, as in Fig. 67, and the distant side the values of 2 each. Then we can add the values of the current flowing in the heavy wire, and we have $4 + 2 = 6$. And in the light line we have $2 + 4 = 6$. If we subtract we have 0.

Therefore the value of the current flowing in the receiver will be nothing, and no sound is heard.

(To be continued)

General Shake-up Features Indiana's Annual Convention

Indianapolis, Ind.—A general stirring-up of association affairs engaged the attention of the 325 telephone men and women who attended the annual convention of the Indiana Telephone Association held at Hotel Claypool, Indianapolis, September 20-22.

The association decided to redistrict the state so the state and district associations would be bound by closer ties, to make district presidents members of the state association's directorate, to have a managerial board for the district associations consisting of the manager of the state association and the president and secretary of each district, and to include mutual and co-operative companies in the state association's membership.

Membership fee in the state association was reduced from $5 to $1. Instead of holding the annual convention in September, as has been the custom for the past eight years, it was agreed to make the annual meeting time in May.

So much for the organization changes decided upon in the shake-up that took place when the Hoosiers in convention assembled. Other energizing and "snapping out of it" took place as a result of a well balanced program started off by the administering of President Barnhart's annual tonic for that tired telephone feeling, which, if taken according to directions, is guaranteed to cure.
presidential address.

As one of the feature details of his address, Mr. Barnhart said: "Is it a forlorn hope that the time is not far in the future when connecting service with dilapidated equipment will be denied until reasonable repairs are made, and that such procedure will be mandatory either by edict of the state and district associations or the public service commission, all working together for the good name and efficiency of telephony as a country-wide insurance for the safety and security of our business?"

90% in Indiana's Fold

Approximately 90 per cent of the stations and toll lines in Indiana are represented in the association's roster, said Charles S. Norton in making his report as secretary-manager of the body. The close of the year since the previous annual meeting found the association in the best financial shape of its history and with a greater representation of the state's telephone industry than ever before showing in its membership lists. The year had smooth sailing on legislative seas for the organization, due to the watchfulness and expert navigation of its heads. Mr. Norton also spoke, later in the convention, on "Organization and Reorganization," detailing some of the work the association was organized to do for its member companies and specifically comparing state association organization and effort with the work of successful industrial corporations.

Speed Sales Work

A. D. Lewis, Indianapolis, Bell division commercial superintendent, addressed the meeting on "Selling Telephone Service." He told of the progress made during the last several years in selling telephone service to the public and set forth some policies to be followed in making a continuous sales program successful.

Carl Wilde, Indianapolis, formerly director of service of the Indiana Public Service Commission, in speaking on "Necessity of State-Wide Regulation of Public Utilities," presented the advantages of having a single regulatory body supervising utility operations. He also related the defects of home rule and franchise and contract arrangements.

President MacKinnon of the national Independent association told the Indiana men to stand together against issuance and exploitation of unsound telephone securities, in describing some of the perils that wild-cat promoters have brought right across the corner from the industry today.

Buckeye Methods

Dr. C. I. Jones, president of the Ohio Independent Telephone Association, on the subject of "How Things Are Done in Ohio," epitomized the reasons for the progress of that state's association.

"Give Help to Little Fellow"

Frank E. Bohn, vice-president and general manager of the Home T. and T. Co., Fort Wayne, gave the convention a healthy session of good advice in his discourse on "The Safety and Security of Our Business." He allied the leading Independent and the Bell interests in the common cause of universal service, and spoke of the Fort Wayne record of the last five years in increasing business through co-operation. He told the convention that it is up to the men who own and operate in the larger centers to help the little fellow.

A. L. Staderman, secretary and engineer of the Citizens Independent of Terre Haute, spoke on "Engineering as Applied to the Telephone Business." He forecast the day when financial engineering would take place among the other engineering activities of the telephone field.

R. V. Achatz, president of the Southern Indiana Telephone Co. and technical editor of TELEPHONE ENGINEER, in telling "How to Handle Service Stations" said the two divisions of the problem were to get the lines in condition to give service and to get the subscribers to take the service.

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Graybar and Bunnell Now Booth Distributors for Churchill

Chicago, Ill.—An important announcement is made by the Churchill Cabinet Co., Chicago, to the effect that it has made arrangements with the Bell interests whereby Churchill and their distributors will now be allowed to sell, anywhere, the "Churchill" patented receding door telephone booth, the folding door booth, and the swinging door booth.

O. Gullicksen

The J. H. Bunnell Co., New York, and the Graybar Electric Co. will be the national distributors.

The announcement means that the folding door telephone booth may now be secured by anybody wishing to benefit by it, north or south, east or west. The telephone industry will welcome this associati on of the Bunnell, Graybar and Churchill companies.

The Churchill Cabinet Co., headed by O. Gullicksen, has been associated with the telephone industry since its inception, and has long been of service to that field in the manufacture of telephone equipment. Mr. Gullicksen personally invented and perfected the Churchill booth. He is an outstanding figure in the industry, and is so recognized.

It is needless to elaborate on the facilities of the Graybar Electric Company. Everybody knows the scope of this organization.

The J. H. Bunnell Company, established in 1878, is well-known for its highly specialized engineering staff, and as high grade manufacturers of telephone and telegraph equipment. J. J. Raftery, president of this company, is another outstanding figure in this industry with which he has long been associated, and is recognized as an authority on telephone booths.

He was for years associated with the Western Electric Co. and in charge of direct booth sales to non-Bell companies. Mr. Raftery enjoys a large acquaintance in the Independent fields.

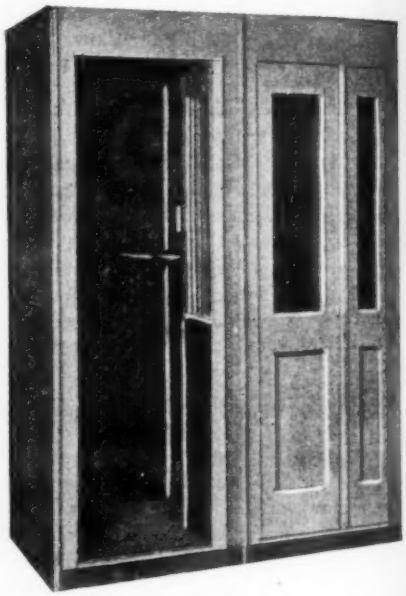
Nelson H. Small, Telephone Engineer for the J. H. Bunnell Co., has an enviable reputation because of his achievements in that capacity. Mr. Small has opened the eyes of the industry as to the possibilities of telephone booths in the direction of "velvet revenue" to operating companies.

Telephone men have recognized to a degree the revenue existent in numerous booths. However, the needed factor was a plan of complete installation and engineering in all its phases. Mr. Small has evolved a plan whereby he can assure the owners or managers of telephone properties of a constant flow of "velvet revenue" by the installation of telephone booths. The combination makes it possible to go into a building, lay out an installation completely, put all the finish on the job, including the interior trim fitted to the woodwork in the building, and furthermore to service the job, making sure that the installation and operation are satisfactory.

The Churchill Cabinet Co. has recognized the value of this plan in the handling of telephone booths, and the creation of this additional revenue for the telephone company—and have therefore made these new connections.

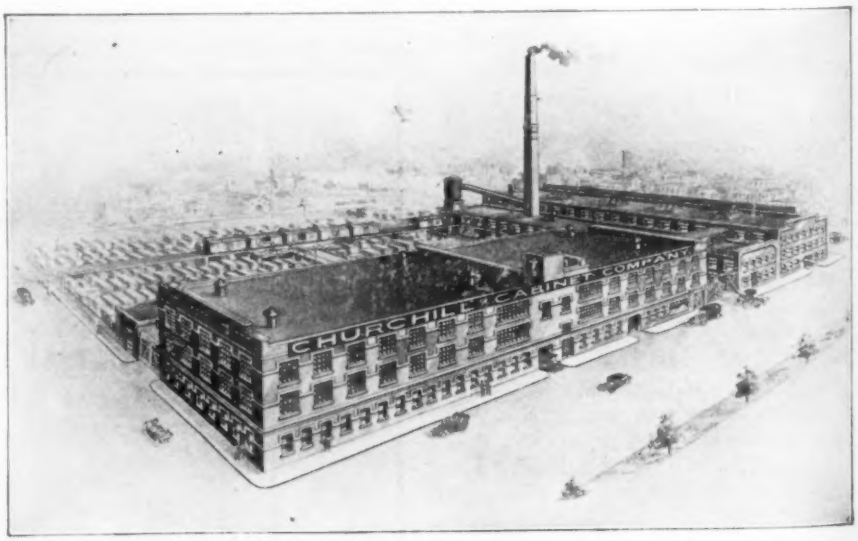
West Lags in Booths

The significance of this development will be brought forcibly to the mind of the telephone man when he learns the surprising fact standing out from a recent survey—namely that the number of telephone booths in use in the Central West and West are very few as compared with those in the East. Many stores, barber shops, beauty shops, shoeshining shops, etc., situated in large buildings, have telephone installations in halls and corridors. In small cities and towns particularly, stores, barber shops, etc., are saved the embarrassment of lending their own telephone equipment and are also afforded a definite avenue of "velvet revenue."



"Churchill" Folding Door Telephone Booth

Another advantage in this connection is that Churchill booths will be warehoused in New York and Chicago, and may be obtained in a number of other stretegic points throughout the country.



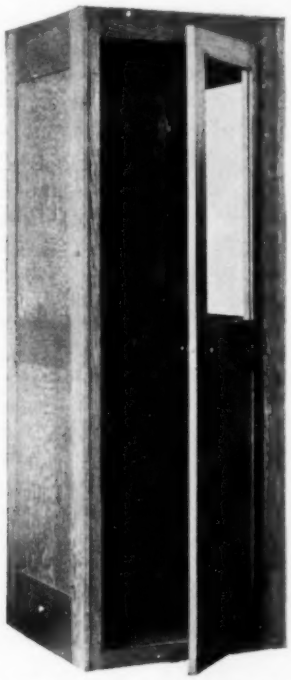
Churchill's Big Factory at Chicago

The J. H. Bunnell Co. announces that its staff of engineers is available to any telephone company, at any location, which

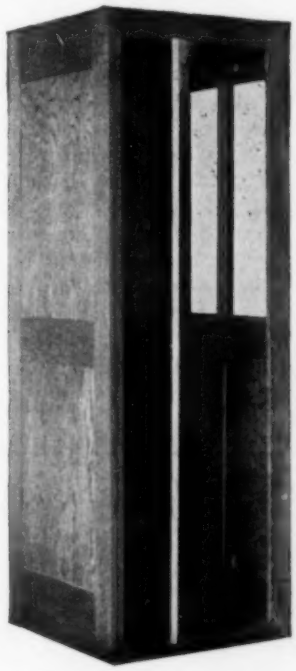
Nelson H. Small

wishes a specially designed booth necessary for its requirements. This applies either to the type of booth or kind of wood or finish desired.

The artistry of the telephone booth is a factor which must be reckoned with, these days, particularly inasmuch as architects find the Churchill Booth worth considering as a built-in feature for factories, stores, office—and, mark this—for even the most luxurious homes.



"Churchill" Swinging Door Telephone Booth



"Churchill" Receding Door Telephone Booth

Jefferson City, Mo.—Public Service Commission has granted authority to Inter-City Telephone Co., P. Kerr Higgins, president, 5596 Pershing street, St. Louis, to issue $200,000 of common stock to purchase following telephone properties: DeKalb County Telephone Co. with exchanges at Maysville, Clarksdale, Osborne, Fairport, Weatherby, Amity and Santa Rosa; Charles S. Lytle Telephone Co. with lines and equipment in DeKalb and Buchanan counties; exchange at Stewartsville, owned by L. H. Roberts Co., and Daviess County Telephone Co. with exchanges at Gallatin, Pattonsburg, Coffey and Jameson.

J. H. Bunnell Co. Headquarters at New York

Harry Dodge Author of Telephone Financing Booklet

Chicago, Ill.—Harry Dodge, one of the well-known veteran telephone men and now vice-president of Paul C. Dodge and Co., Inc., and investment house of Chicago, has written an interesting booklet, "The Telephone—An Essential Public Utility." This booklet treats of the features of well managed telephone company securities and outlines some of the methods of financing telephone companies.

The booklet is intended for telephone companies as well as for investors, and a copy will be sent free to any interested telephone man. Requests should be addressed to Paul C. Dodge & Co. at 10 South La Salle street.

South Dakota Sets. Jan. 10-12 for Meeting

Huron, S. Dak.—South Dakota Telephone Association has decided upon January 10, 11, 12, 1928, as the dates of its next annual meeting which is to be held at Hotel Marvin Hughitt, Huron.

SET STAGE FOR BIG U. S. I. T. A. MEETING

(*Continued from page 27.*)

On this matter a statement from association headquarters reads:

"A rate of one and one-half fare is granted on the certificate plan as is explained. As in prior years the rate is based upon two hundred and fifty certificates being filed with our secretary at the convention. This makes it a matter of importance that everyone attending the convention should obtain a certificate not only that he himself may be able to secure the reduced rate for his return ticket, but so that others who attend may also secure that rate. Therefore please see to it that all of your employes and the representatives of your neighboring companies who attend the convention obtain the necessary railroad certificates.

"We have had no difficulty in securing sufficient certificates to secure the rate, but are afraid that the forgetfulness of some of our members may sometime prevent our securing sufficient certificates, therefore we urge you to pay attention to this matter of obtaining the necessary certificate of purchase."

Exhibit Space Sold Out

All of the exhibit space available was sold out several weeks before the convention and a number of late candidates for showing at the Independent meeting met with disappointment. Manufacturers have been planning for the last few months to make this year's convention one of striking interest and practical benefit in the showing of the latest developments in equipment and supplies.

Following is a list of the manufacturers who will appear in the available exhibit spaces: American Electric Co., Inc., Automatic Electric Inc., L. M. Berry & Co., Bowdle Accounting System, Lynton T. Block & Co., Chance Co., Coffey System & Audit Co., Cook Electric Co., Electric Storage Battery Co., Everstick Anchor Co., French Battery Co., Harrah Manufacturing Co., Holtzer-Cabot Electric Co., A. J. Johnson Electric Co., Kellogg Swbd. & Sup. Co., Leich Electric Co., National Cable Compound Co., National Carbon Co., Inc., Page & Hill Co., Quick Directory Co., Reliable Electric Co., John A. Roebling's Sons Co., Runzel-Lenz Electric Co., Sands Electric Co., Stacy Swivel Load Binders, Stromberg-Carlson Tel. Mfg. Co., Carbon Products Co., Templeton, Kenly & Co., W. N. Matthews Corp., Unique Manufacturing Co., Inc., Signal Engineering & Mfg. Co., American Steel & Wire Co., Highway Trailer Co., Copperweld Steel Co.

Pioneers to Star

Independent Telephone Pioneers, in accordance with the practice of that organization for the last several years, will stage the big entertainment feature of the convention. The nature of this entertainment will not be revealed in advance and much is being made of the mystery element.

John Jaap, Cook Electric; George Rodormer, Reliable Electric; C. W. Shafer, Stromberg-Carlson; A. D. Boal, Kellogg; O. V. Dodge, Automatic Electric; L. Q. Trumbull, American Electric, and Frank Eldridge of Eldridge Bros., forming the Pioneers' entertainment committee, have been busy for a couple of weeks preparing the surprise party.

The Pioneers at the Chicago convention will make the first showing of their historical exhibit. This collection of relics of the development of Independent telephony is being made under the supervision of J. K. Johnston, secretary-treasurer of the organization, and pleasing progress is reported. It is expected that the showing of the first collection of historical items at the Chicago convention will spur interest and contributions so the proposition eventually will become one of the important items of the country's industrial history.

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A Dependable Combination

UNIQUE { FURNACE / SOLDER POT / LADLE / WIND-SHIELD

See Them at the Convention
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Write for New Literature

Unique Manufacturing Co.
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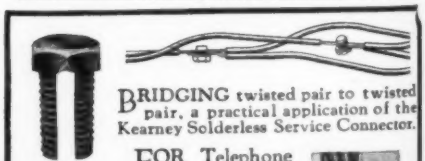
Magneto Telephones

Dean Electric Co. walls.
Stromberg-Carlson walls.
Kellogg Switchboard & Supply Co. walls.
Western Electric Co. walls.
American Elec. Co. (Sampson type) walls
Chicago Telo. Mfg. Co. walls
Kellogg, W. E., Chicago and Dean desk

BUCKEYE TELEPHONE & SUPPLY CO.
Columbus Ohio



BRIDGING twisted pair to twisted pair, a practical application of the Kearney Solderless Service Connector.

FOR Telephone Lines in making party line taps, order Catalog No. 86. The tap can't slacken off. This connector is for No. 12 wire or smaller.

Unassembled Connector

ASK ABOUT KEARNEY CERTIFIED MALLEABLE SCREW TYPE ANCHORS

Kearney Guy Wire Serving Clips. Eliminate Serving End of Strand. Made of Aluminum, Copper, and Galvanized Iron.

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NORTHERN
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Manufactured as you'd like to have them—
STOCKY and STRAIGHT
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DEPENDABILITY and long life are the two essentials in a contact point. This "heart of the machine" should function evenly and steadily over long periods of time—it should not need replacement at frequent intervals.

Baker Contact Points are made with this principle always in mind and the name "Baker" assures that perfect performance, without constant renewal, which is the outstanding characteristic of a *good* contact point. Our contacts are made of Platinum, Iridio-Platinum, Silver and Special Alloys. There are sizes and types for all purposes.

BAKER & CO., INC.
54 Austin St., Newark, N. J.
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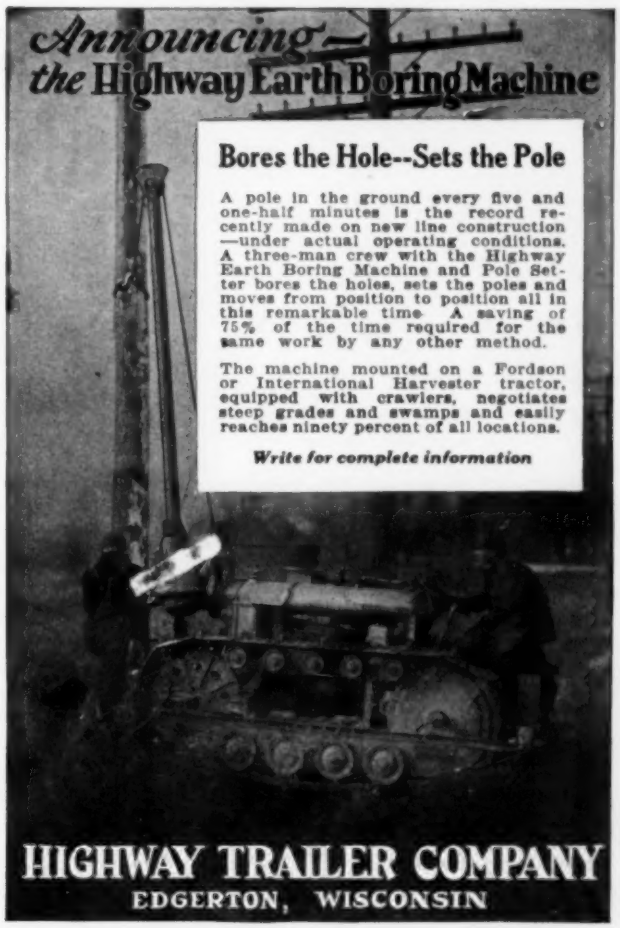
Announcing— *the* **Highway Earth Boring Machine**

Bores the Hole--Sets the Pole

A pole in the ground every five and one-half minutes is the record recently made on new line construction—under actual operating conditions. A three-man crew with the Highway Earth Boring Machine and Pole Setter bores the holes, sets the poles and moves from position to position all in this remarkable time. A saving of 75% of the time required for the same work by any other method.

The machine mounted on a Fordson or International Harvester tractor, equipped with crawlers, negotiates steep grades and swamps and easily reaches ninety percent of all locations.

Write for complete information



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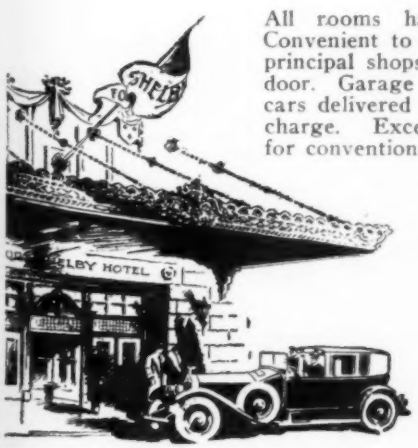
LAFAYETTE AND FIRST DETROIT

WHETHER your choice be one of the many very comfortable rooms at $2.50, $3 or $4, or one of the richly furnished suites in the 22-story recent addition, whose sunny bay windows give an entrancing view of city, river and Canadian shore, you will enjoy a special sense of value in Hotel Fort Shelby.

All rooms have Servidors. Convenient to all downtown; principal shops almost at the door. Garage in connection; cars delivered without service charge. Excellent facilities for conventions.



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Built for the Lineman!

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When we designed Vacuum Grip No. 58 we studied the linemen's needs and *built a pair of pliers to meet them.* No. 58 is *your* plier—made to do *your* kind of work—*without breaking down!*

They are *not made of ordinary carbon steel, case-hardened* but of high grade electric furnace tool steel, *HARDENED THRU AND THRU* and tempered in oil.

GUARANTEED to give 100% satisfactory service or purchase price refunded.

No. 56—6 in., price $2.25; No. 57—7 in., price $2.75; No. 58—8½ in., price $3.50. We pay parcel post.

If your dealer can't supply you use the coupon. Write for Catalog of 38 sizes and patterns. PURCHASING AGENTS, send for samples for your men to use in running tests.

FORGED STEEL PRODUCTS CO.
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Newport, Penna.

Enclose ..... (Money Order) for one pair No. ..... Vacuum Grip Pliers.

Name .....

Street .....

City ..... State .....

T-9

Practical Suggestions for Plant Valuation

By CHARLES W. McKAY, M. E.*

CHAPTER IV

In the last installment we considered the subject of inventorying the underground conduit plant, in connection with Figure No. 5—in other words, we considered accounts 244 and 254. In the last installment it was also suggested that the inventory of the underground cable plant—to wit, accounts 245 and 255—would be discussed in the October installment.

Fig. 6, as presented herewith, is drawn up to correspond exactly with Fig. 5 as to topography, manhole locations and lateral duct locations.

We come out of the central office on First street running west with three 1200-pair cables and east with one 1200-pair cable. At manhole No. 2, one of three west bound 1200-pair cables runs south to manhole No. 3 where it divides into one 600-pair cable extending south; one 300-pair cable extending east and one 300-pair going west.

From manhole No. 2 to manhole No. 4 one 1200-pair cable extends and at the latter location it divides into a 600-pair cable going north; a 600-pair extending east and a 100-pair cable extending to lateral pole "A."

From manhole No. 2 two 1200-pair cables extend to manhole No. 5. One of these extends west to manhole No. 8, while the other divides into a 600 pair running north to manhole No. 6; a 600-pair extending south to manhole No. 7 and a 200-pair lateral cable connecting with the house cable in the basement of the office building at the southeast corner of Adams and First streets.

All of the splices are denoted by heavy dots. Care should be taken to record all splice and stub data. The stubs, on a 1200-pair cable, may be 400 pair (or even larger) and extend nearly around the manhole. Furthermore, the first cost of stubbing a cable is appreciable and should be taken into account.

Beginning at the central office main frame we have 24 200-pair silk and cotton terminating cables dropping vertically to the basement and thence laterally to manhole No. 1. Or, what would probably be better practice, we would have these cables spliced directly to the 4 1200-pair cables in the basement of the central office. In any event, the 200-pair terminating cables should be measured and recorded—due allowance being made for the lengths required to properly terminate the cables on the main frame. All of this terminating cable should be included under account 245.

From manhole No. 1 to manhole No. 2, we have a 50-foot center to center length. From manhole No. 2 to No. 5, we have a 500-foot center to center measurement. The center to center measurements are also illustrated for the sections between manholes Nos. 5 and 6; manholes Nos. 5 and 7 and manholes Nos. 5 to 8.

Knowing the width of the manholes, it is a comparatively simple matter to make adequate allowance for slack in the manholes and also for splicing slack.

In connection with the 100-pair lateral from manhole No. 4, allowance should be made both for the horizontal run and for the vertical distance up the pole to the aerial cable. Also, in connection with the 200-pair lateral from manhole No. 5 to the house cable in the office building—the horizontal measurement should be made from the manhole to the point in the basement where the lateral cable joins the vertical house cable riser.

The house cable, and all the terminals thereto, should also be inventoried and classified as part of account 245.

It is thought that this simple diagram, with the accompanying narrative, will serve to explain the method of inventorying the underground cable plant.

As suggested in a previous installment, the outside plant inventory has been discussed before taking up the subject of recording data pertinent to central office equipment (accounts 221 and 222) and subscribers station equipment (accounts 231 to 235). The reason for this is that the outside plant is usually recorded first—or at least while weather conditions are favorable. The inside plant is always accessible.

The subject of recording inventory data pertinent to the inside plant—accounts 221, 222 and 231 to 235—will be discussed in the November installment.

Melvin, Ill.—Paxton Telephone Co. has bought the Melvin telephone system.

Cape Girardeau Telephone Co., and associates, have bought the Ideal Telephone Co. of Illmo.

Nashua, Mont.—Rochland Farmers Telephone Co. has completed building of 25 miles of line. C. O. Spangler is president of company.

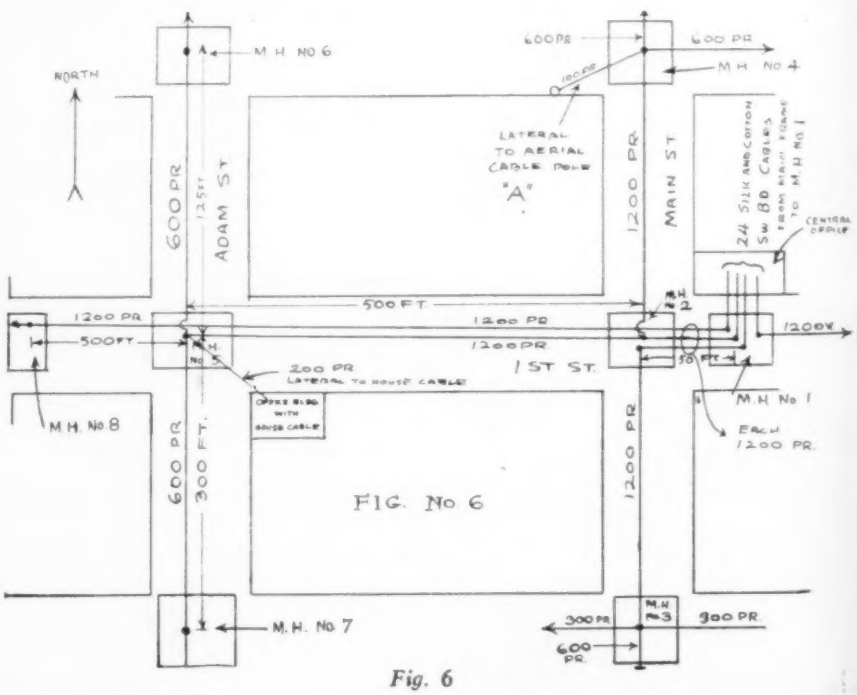


Fig. 6

Consulting Telephone Engineer, 448 Wrigley Building, Chicago.

Eddie Schulz, Boy Battery Wonder, Is Benedict

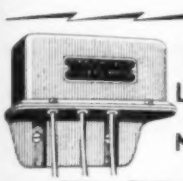
Chicago, Ill.—National Carbon Co. officials are looking forward to the greatest year in the history of the organization due to the expected increase in telephone battery sales to be made by young Mr. Eddie Schulz. The week following the Indiana telephone convention Eddie deliberately committed matrimony, which always is a decided inspiration for increasing one's sales and income.

As a benedict Eddie will have gone through one first of the month prior to the National Independent convention at Chicago and it is confidently hoped by his employers that Master Schulz, mindful of his new responsibilities, will peddle batteries to the convention attendants in such tremendous quantities that his bride can take her share of the increased income amounting to (according to our experience) 175 per cent of the husband's total earnings and bring expansive smiles and light hearts to the tradespeople engaged in selling women's apparel and the items necessary to pad the cell of the happy young couple.

Eddie's customers, competitors and just friends, in the aggregate constituting a goodly part of the telephone industry, wish him and the young lady who took him for better or worse, 100 per cent of the better.

Following a honeymoon spent in seeing how far the Schulz roll will go in Frank Eldridge's jewelry store (adv.), the newly weds will be at home in a Pullman unless Eddie changes his manner of living.

Preston, Neb.—Southeastern Nebraska Telephone Co. has bought the Preston Telephone Exchange from the Farmers Mutual Telephone Co.



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Federal Brand New 4-bar 1600 ohm Bdg. Grab-a-Phones @	9.00
Cook No. 10 Arresters, per bank of 20 lines @	8.50
Cook No. 8 Arresters, per bank of 20 lines @	8.00
Stromberg No. 599 type 4-bar 1000, 1600 or 2500 ohm Bdg. compacts @	6.90
Bunnell 50 ohm. Automatic Pen Registers. Register calls from Police or Fire Alarm boxes @	20.00
Kellogg No. 20-A Cord Ckt. Repeating coils @	1.25
Kellogg No. 128 Twin Swbd. condensers @	1.00
Leich Elec. No. 7A Frequency converters @	37.50
Bunnell Telegraph Keys @	.50
General Elec. (THOMAS), A. C. Ammeter, Scale 0 to 2 amps. @	5.0
Dean Elec. 3-bar 1000, 1600 or 2500 ohm Bdg. desk sets @	8.75
Kellogg No. 28 3-bar 1000, 1600 or 2500 ohm Bdg. desk sets @	9.50
Western Elec. No. 296A Straight line C. B. Wood hotel sets with No. 229 Trans., No. 143 Rec., No. 20 Coils and 2500 ohm ringer @	6.50
Menominee Elec. Extra Heavy duty Swbd. Gen., complete with mounting screws, crank, etc., 6-bar @	2.75

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